Subsurface Conditions
Data Report
404 Permit Support
Third Runway Embankment

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Prepared for
HNTB Corporation and
The Port of Seattle

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SUBSURFACE CONDITIONS DATA REPORT
404 PERMIT SUPPORT
THIRD RUNWAY EMBANKMENT

INTRODUCTION

This data report presents a discussion of subsurface conditions, laboratory testing, and relevant geotechnical and hydrogeologic field testing to support the 404 Permit process for the Third Runway Project. The site is located at the Sea-Tac International Airport, in SeaTac, Washington (refer to Figure 1, Vicinity Map). Figure 1 shows specific areas within the airport vicinity where we have performed explorations for this study. These areas are presented as site and exploration plans, Figures 2 and 3. Cross sections showing inferred geologic conditions are provided on Figures 4 through 6. Finally, a groundwater elevation contour map for the Regional Shallow Aquifer is shown on Figure 7.

This report provides the data used in engineering analyses which will be presented in other reports. We have organized this report into several sections. The main text starts with a discussion of site surficial geology and subsurface conditions. This is followed by a discussion of the hydrogeologic conditions and testing information we have obtained from our explorations to date. Appendices A and B follow the main text and present results of our subsurface explorations and laboratory testing, respectively.

PURPOSE AND SCOPE

This report provides information on subsurface soil and groundwater conditions for the planned Third Runway within the areas represented by our explorations. This documents addresses scope item Task 2.3, "Characterization of Subsurface Conditions" discussed in our proposal dated January 28, 1999. Additional information on subsurface conditions will be obtained to support completion of design. Tasks 2.1, "Subsurface Explorations," and 2.2 "Laboratory Soils Testing," also part of the January proposal, were completed to provide information for this report.

GENERALIZED GEOLOGIC DESCRIPTION AND SUBSURFACE SOIL CONDITIONS

This section provides a description of the geologic and subsurface soil conditions within the areas shown on Figures 2 and 3 based on our recent explorations at the site and explorations by others. Previous studies into the local geologic conditions at the Third Runway have been accomplished by AGI Technologies (AGI, 1998 and 1996) and CivilTech (1997).

Generalized Geologic Conditions

The site is located on the Des Moines Drift Plain in the Puget Sound Lowland. Glacial soils have been deposited and extensively reworked by glacial episodes, the most recent being the Vashon glaciation. This section presents the geologic conditions within the study areas shown on Figures 2 and 3.

In summary, the following geologic units have been identified at the Third Runway project site:

- Fill (loose to medium dense, locally dense, variably graded, silt, sand, and gravel);
- Alluvium (primarily soft to stiff peat and silt; and very loose to medium dense, fine to medium sand);
- Recessional Outwash (primarily medium dense to dense, silty, sand and gravel, and/or medium stiff to hard, sandy silt and/or sandy clay);
- Glacial Till (dense to very dense, silty sand and gravel);
- Advance Outwash (dense to very dense, non-silty to silty sand and gravel); and,
- Lawton Clay (very stiff to hard silt and clay).

The area immediately adjacent to the western side of the existing runway embankment has been mapped as glacial till. This has been reported to occur as a band of material paralleling the existing runway (AGI, 1996). Our explorations adjacent to the existing runway embankment suggest that recessional outwash deposits are the predominant surficial material with glacial till typically at a relatively shallow depth. The glacial till appears to outcrop in small areas within recessional outwash.

Subsurface Conditions

Subsurface soil conditions interpreted from materials encountered in explorations at the site and soil properties inferred from laboratory tests formed the basis for the information contained within this report. Variations between explorations are pronounced due to the variability in gradation, moisture content, and density/consistency of soils at the site. The nature and extent of these variations may not become evident until construction. If variations become evident, it will be necessary to re-evaluate our interpretation of the soil conditions at the site, as well as any recommendations based on those interpretations.

Subsurface conditions in the north area shown on Figure 2, generally consists of a glacial sequence (recessional outwash sands over glacial till over silty advance outwash), and in low-lying areas, an alluvial sequence over glacial materials (alluvial silt, sand, and peat over glacial till). Subsurface conditions encountered on the west side were very similar. Figures 4 through 6 provide generalized geologic cross sections through the north end and west side of the proposed embankment. Each area has two associated sections, one cross section taken perpendicular to the wall/embankment, and one profile along the alignment of the proposed retaining wall. Detailed descriptions of the materials we encountered are provided below.

The following descriptions have been separated into categories entitled "Shallow Soils" and "Deeper Soils."

- Shallow soils are those that would be encountered during construction excavations into surficial soils for base preparations purposes.

- Deeper soils are considered the dense to very dense or hard, glacially overridden soils.

The latter are materials that will provide foundation support for the embankment fill and retaining wall sections without need for modification.

Shallow Soils

Topsoil. This soil was not consistently encountered in our explorations. Typically, this soil consists of a loose mixture of silt and sand with roots and other organic material. Topsoil is generally 1/2 to 1 foot thick where encountered. Many of the surficial soils at the site appear to be glacial soils at different stages of weathering. This is further discussed in the **Recessional Outwash** and **Glacial Till** sections below.

Fill Soils. Fill soils were encountered in both the north and west study areas, typically associated with access roads, paved streets, or general grading activities. Fill is generally absent in the low-lying portions of the site, adjacent to wetlands. Fill soils are generally loose to medium dense, variable mixture of silt, sand, and gravel. The density and granular nature of the fill materials resembles the recessional outwash deposits and the fill is sometimes difficult to distinguish from the outwash.

North of the runway safety area, fill thickness is generally up to about 8 feet and is primarily associated with roads and grading for residential development (refer to Figure 1). Fill was also encountered in some of the 1999 test pits (i.e., HC99-TP10 to HC99-TP21) performed on the western side of the north safety area. This material was up to 3 feet in thickness and contained brick fragments, concrete pieces, wood, and other miscellaneous debris.

Within the west study area, fill was encountered near the existing runway embankment in the area of the Hart Crowser 1998 and 1999 test pits (i.e., HC98-TP1 to HC98-TP12 and HC99-TP1 to HC99-TP21).

Alluvial Deposits. These soils occur in the low-lying areas and generally consist of soft/loose, moist to wet, interlayered silt, sand, and peat or, in places, a single peat layer. The north study area contains a thick layer of very soft, highly compressible peat, generally less than about 15 feet thick (CivilTech, 1997). However, other locations in the north study area contain thick sequences of very soft to soft peat, silt, and clay with layers of loose to medium dense, fine sand (e.g., CT97-B1, contained the soils described, throughout the 46.5-foot depth of the exploration). Peat also occurs as interbedded layers within very soft to medium stiff silt and very loose, slightly silty to silty sand. These silt and sand layers range up to about 6 feet thick. Standard penetration test (SPT) blow counts within the peat layers in the west study area borings, HC99-B37 and HC99-B38, indicates these soils range up to a relatively stiff condition.

Recessional Outwash. This material is generally medium dense to dense, slightly silty to silty, slightly gravelly to gravelly sand. Recessional outwash overlies the glacial till, or advance outwash where the glacial till has been eroded. Thickness of the recessional deposits varies over the site, but is generally less than 20 feet. Localized areas have thicker deposits of recessional outwash, such as in the west study area near AT94b-B4. The recessional deposits are generally absent where alluvial materials are located and dense to very dense glacial till or advance outwash sand and gravel underlies the alluvium.

Where recessional soils are located at the ground surface, the soil is in a weathered condition, typically more loose and higher in moisture content. These loose materials become medium dense at relatively shallow depths, typically less than about 10 feet. This layer may become colluvium where deposits are on sufficiently sloping ground. Gradation of the recessional outwash varies both vertically and laterally throughout the layer as shown in the relevant grain size curves of Appendix B (e.g., HC99-B40, S-4; HC98-TP4, S-4; and HC98-TP10, S-4).

In the north study area, layers of soft to hard, sandy silt to silt were encountered interbedded with the sand and gravel layers of the recessional outwash deposits. The profile along the north wall (refer to Figure 6) illustrates the interbedding of this soil unit above the glacial till layer. This soil typically has a consistency of medium stiff to hard, but becomes soft near the surface. The soil is of low plasticity, generally with a plasticity index less than about 16. This material has some frictional strength due to its low plasticity and sand content as shown from the laboratory testing. In addition, this soil is of significantly lower permeability than the surrounding recessional soils.

Deeper Soils

Glacial Till. The till soils comprise the predominant glacially overridden soil unit underlying the surficial materials discussed above. This material is generally dense to very dense, slightly gravelly to gravelly, silty to very silty sand. The gradation of the till soils varies both vertically and laterally (e.g., HC99-B32, S-4; HC99-B35, S-4; HC99-38, S-4; and HC98-TP6, S-6).

In general, glacial till differs from the overlying recessional soils by having a higher silt content and much higher density. The top of the glacial soils is generally within 10 to 20 feet of the ground surface at the north end and west side. Some weathering was noted near the surface of the glacial till soils in explorations for both study areas.

Advance Outwash Sand. This material is generally dense to very dense, slightly silty, slightly gravelly to gravelly sand. In general, the advance outwash can be distinguished from the glacial till by lower silt content. Representative gradation curves would typically resemble those for samples HC99-B31, S-5; HC98-TP4, S-4; and HC98-TP7, S-8. However, observations at the site suggest that some areas of advance outwash are silty, which adds complexity to interpretation.

Lawton Silt/Pre-Vashon Deposits. The hard silt soils interpreted to be part of these geologic units in previous studies were not encountered in our explorations, but would likely be encountered at greater depths. These hard silt soils may be laminated or contain planes of separation (partings). Furthermore, these silt deposits are typically reported to be relatively plastic and are often slickensided (i.e., showing evidence of previous failure planes).

Study Area Generalized Hydrogeologic Regime

Within the Miller Creek drainage, the Advance Outwash appears to be thicker to the north and to the east of the creek drainage, beneath the airport (AGI, 1998). The Advance Outwash, also known as the Shallow Regional Aquifer, discharges to Miller and Des Moines Creeks, and via underflow to Puget Sound and the Green River valley (AGI, 1996).

Hydrogeologic Conditions

Groundwater elevation data were collected and slug testing performed to obtain data for estimating hydraulic conductivity values. These data and analyses are discussed below. The slug testing was performed in several areas of the drainage basin adjacent to Miller Creek, and water level measurements were collected within the drainage basin near Miller Creek, and on the flanks of the drainage basin beneath the existing airport embankment. Water levels vary over time, as indicated in Table 1.

Artesian conditions were encountered east of the north safety area. Initially, our exploration HC99-B43 encountered artesian pressure at 24.5 feet in depth. The water flowed freely from the well. Later, we advanced exploration HC99-B43A in the same area to install an observation well with a pressure gage to measure the excess head. HC99-B43A encountered the artesian pressure condition at a depth of 29 feet. The pressure gage was installed and read less than 5 psi.

Artesian conditions were also encountered in exploration AT97-B41, located near HC99-B43 but no pressure measurements are reported.

Artesian pressures are likely sustained by recharge occurring in higher elevation areas of the existing airport area to the south. However, continuity of the advance outwash soils and extent of such conditions will need to be further assessed.

Hydraulic Conductivity Testing

A pumping test was originally planned for HC-B33. However, the well yield was inadequate because of lower permeability soils, making a pumping test impractical based on the well's low flow-rate. Therefore, slug tests were performed on a larger number of wells.

Slug testing was performed on wells within the study areas shown on Figures 8 and 2. Slug tests were performed on six wells in the area northwest of the airport (HC99-B31 through HC99-B36, shown on Figure 2), and on four wells to the west of the airport (HC99-B37 through HC99-B40, shown on Figure 3). Hydraulic conductivity values are summarized in Table 2. Test results are grouped by material type observed within the screened interval and by area. In the northwest study area (Figure 2), the geometric mean hydraulic conductivity for gravelly coarse sands was 6.5×10^{-3} cm/sec. For silty sands in this area, the geometric mean was 1.8×10^{-4} cm/sec. In the western study area (Figure 3), the wells were screened in silty sands, and the geometric mean hydraulic conductivity was 1.1×10^{-4} cm/sec.

Groundwater Flow Mapping

Groundwater levels were measured in eighteen wells. Groundwater elevations are contoured on Figure 7 for the Shallow Regional Aquifer, illustrating groundwater flow directions.

Groundwater flow is generally toward Miller Creek from the higher ground of the airport. It appears that significant recharge occurs on the higher ground of the airport, and that water moves down into the Shallow Regional Aquifer, and discharges to the creek drainage. At greater depths in and near the Miller Creek drainage basin, there is an upward hydraulic gradient, indicating the groundwater flow is discharging to the creek drainage basin.

There are limited indications of downward gradients beneath the plateau formed by the airport. This pattern is consistent with the implied occurrence of significant recharge beneath the existing airport. Based on the stratified nature of the subsurface soils, perched zones can occur above the main water table. In turn, the water table may not always be clearly defined due to the presence of perching layers and the transition occurring from vertical to horizontal groundwater flow.

Hart Crowser completed this work in general accordance with our proposal dated January, 28, 1999. This report is for the exclusive use of HNTB, the Port of Seattle, and their design consultants for specific application to the Third Runway project and site. We completed this study in accordance with generally accepted geotechnical/hydrogeologic practices for the nature and conditions of the work completed in the same or similar localities, at the time the work was performed. We make no other warranty, express or implied.

Sincerely,

HART CROWSER, INC.

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22484
REGISTERED
PROFESSIONAL ENGINEER
9/30/99
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Table 1 - Water Level Data

East of 12th	AT96-B1 Depth* in Feet	AT96-B1 Elevation in Feet	AT97-B69 Depth* in Feet	AT97-B69 Elevation in Feet	AT96A-B8 Depth* in Feet	AT96A-B8 Elevation in Feet	AT96A-B10 Depth* in Feet	AT96A-B10 Elevation in Feet	AT97-B41 Depth* in Feet	AT97-B41 Elevation in Feet	AT97-B42 Depth* in Feet	AT97-B42 Elevation in Feet	HC99-B41 Depth* in Feet	HC99-B41 Elevation in Feet
Top of Monument														
Measuring Point	0.00	407.7	0.00	337.2	0.00	*412.7*	0.00	319.7	0.00	*312.2*	0.00	*325.2*	0.00	340.73
Ground Level*	*-0.3*	*408*	3.2	*334*	*-0.3*	*413*	*-0.3*	*320*	*3.2*	*309*	*3.2*	*322*	2.8	337.93
Top of Screen*	78	330	28	310	50	363	24	296	81	231	23	303	37.80	302.93
Bottom of Screen*	88	320	30	308	61	352	34	286	83	229	28	298	47.80	292.93
Date: 3/8/1999									Flowing	>312	21.21	303.94	31.87	308.86
3/10/1999	dry	dry	6.18	331.02			8.15	311.55						
4/5/1999	dry	dry	6.59	330.61			8.11	311.59	Flowing	>312	21.59	303.56	32.57	308.16
5/4/1999	dry	dry	7.43	329.77			8.35	311.35	0.91	311.24	22.17	302.98	33.17	307.56
5/15/1999											22.22	302.93	33.24	307.49
											to be abandoned		to be abandoned	
6/14/1999	dry	dry	8.08	329.12	47.86	364.84	8.74	310.96	1.27	310.88	22.58	302.57	33.56	307.17

West of 12th	AT97-B57 Depth* in Feet	AT97-B57 Elevation in Feet	HC99-B31 Depth* in Feet	HC99-B31 Elevation in Feet	HC99-B32 Depth* in Feet	HC99-B32 Elevation in Feet	HC99-B33 Depth* in Feet	HC99-B33 Elevation in Feet	HC99-B34 Depth* in Feet	HC99-B34 Elevation in Feet	HC99-B35 Depth* in Feet	HC99-B35 Elevation in Feet	HC99-B36 Depth* in Feet	HC99-B36 Elevation in Feet
Top of Monument														
Measuring Point	0.00	*235.7*	0.00	266.24	0.00	266.29	0.00	265.65	0.00	267.63	0.00	294.58	0.00	275.03
Ground Level*	*-0.3*	*236*	2.5	263.74	3.1	263.19	2.9	262.75	2.4	265.23	2.0	292.58	2.4	272.63
Top of Screen*	13	395	17.50	248.74	13.10	253.19	11.90	253.75	7.40	260.23	15.00	279.58	6.40	268.63
Bottom of Screen*	23	385	27.50	238.74	23.10	243.19	21.90	243.75	17.40	250.23	25.00	269.58	10.40	264.63
Date: 3/8/1999			2.38	263.86	3.55	262.74	2.71	262.94	4.72	262.91	4.69	289.89	4.73	270.30
4/5/1999			2.41	263.83	3.51	262.78	2.64	263.01	4.68	262.95	5.13	289.45	5.01	270.02
5/4/1999			2.58	263.66	4.14	262.15	3.19	262.46	5.44	262.19	5.58	289.00	5.83	269.20
6/14/1999	2.11	233.59	2.93	263.31	4.75	261.54	2.61	263.04	5.88	261.75	6.48	288.10	6.23	268.80

Bold = Measured or Surveyed
Italics = Estimated
Depth* All depths are below Measuring Point (NOT below the ground surface)

Table 1 - Water Level Data

East of 12th	HC99-B43A		HC99-B45		HC99-B46		HC99-B47	
	Depth* in Feet	Elevation in Feet	Depth* in Feet	Elevation in Feet	Depth* in Feet	Elevation in Feet	Depth* in Feet	Elevation in Feet
Top of Monument								
Measuring Point	0.00	295.58	0.00	285.29	0.00	332.82	0.00	281.22
Ground Level*	*3*	*292.58*	3.1	282.19	2.0	330.82	2.4	278.82
Top of Screen*	27	268.58	8.10	277.19	30.00	302.82	7.4	273.82
Bottom of Screen*	37	258.58	13.10	272.19	40.00	292.82	12.4	268.82
Date: 3/8/1999			6.70	278.59	22.01	310.81		
3/10/1999								
4/5/1999	Under Pressure		7.50	277.79	22.48	310.34		
5/4/1999	-10	306	7.93	277.36	23.09	309.73	6.26	274.96
5/15/1999								
6/14/1999	-9	304.81	8.99	276.30	23.75	309.07	7.44	273.78

West of 12th	HC99-B37		HC99-B38		HC99-B39		HC99-B40	
	Depth* in Feet	Elevation in Feet	Depth* in Feet	Elevation in Feet	Depth* in Feet	Elevation in Feet	Depth* in Feet	Elevation in Feet
Top of Monument								
Measuring Point	0.00	237.65	0.00	230.88	0.00	230.80	0.00	250.63
Ground Level*	3.1	234.55	3.3	227.58	*-0.3*	*231.10*	2.0	248.63
Top of Screen*	9.10	228.55	12.30	218.58	4.70	226.10	14.00	236.63
Bottom of Screen*	19.10	218.55	22.30	208.58	14.70	216.10	24.00	226.63
Date: 3/8/1999	3.52	234.13	4.40	226.48	0.69	230.11	4.88	245.75
4/5/1999	3.58	234.07	4.41	226.47	0.74	230.06	5.26	245.37
5/4/1999	3.82	233.83	4.60	226.28	0.86	229.94	5.75	244.88
6/14/1999	5.12	232.53	5.90	224.98	1.68	229.12	6.89	243.74

Table 2 - Summary of Hydraulic Conductivity Estimates

Location	Soil Types in Screen Interval	Hydraulic Conductivity in cm/sec
Northwest Area		
	Gravelly Coarse Sands	
HC-B31	Dense, gravelly, fine to coarse SAND	1.0×10^{-2}
HC-B32	Loose to dense, slightly silty to silty, medium to coarse SAND	3.7×10^{-3}
HC-B34	Medium dense to dense, very silty SAND to very gravelly, coarse SAND	7.5×10^{-3}
	Geometric Mean:	6.5×10^{-3}
	Silty Sands	
HC-B33	Very dense, slightly gravelly, very sandy SILT to very silty SAND	2.0×10^{-4}
HC-B35	Dense to very dense, slightly gravelly, very silty SAND	3.0×10^{-4}
HC-B36	Medium dense, very silty SAND	9.5×10^{-5}
	Geometric Mean:	1.8×10^{-4}
West Area		
	Silty Sands	
HC-B37	Dense, very silty, fine to medium SAND, and sandy silty PEAT	9.5×10^{-5}
HC-B38	Soft, slightly sandy SILT, and very dense, slightly gravelly to gravelly, silty SAND	7.0×10^{-5}
HC-B39	Medium dense to very dense, slightly gravelly, silty, fine SAND	1.5×10^{-4}
HC-B40	Medium dense to very dense, slightly gravelly, silty SAND	1.3×10^{-4}
	Geometric Mean:	1.1×10^{-4}

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Vicinity Map

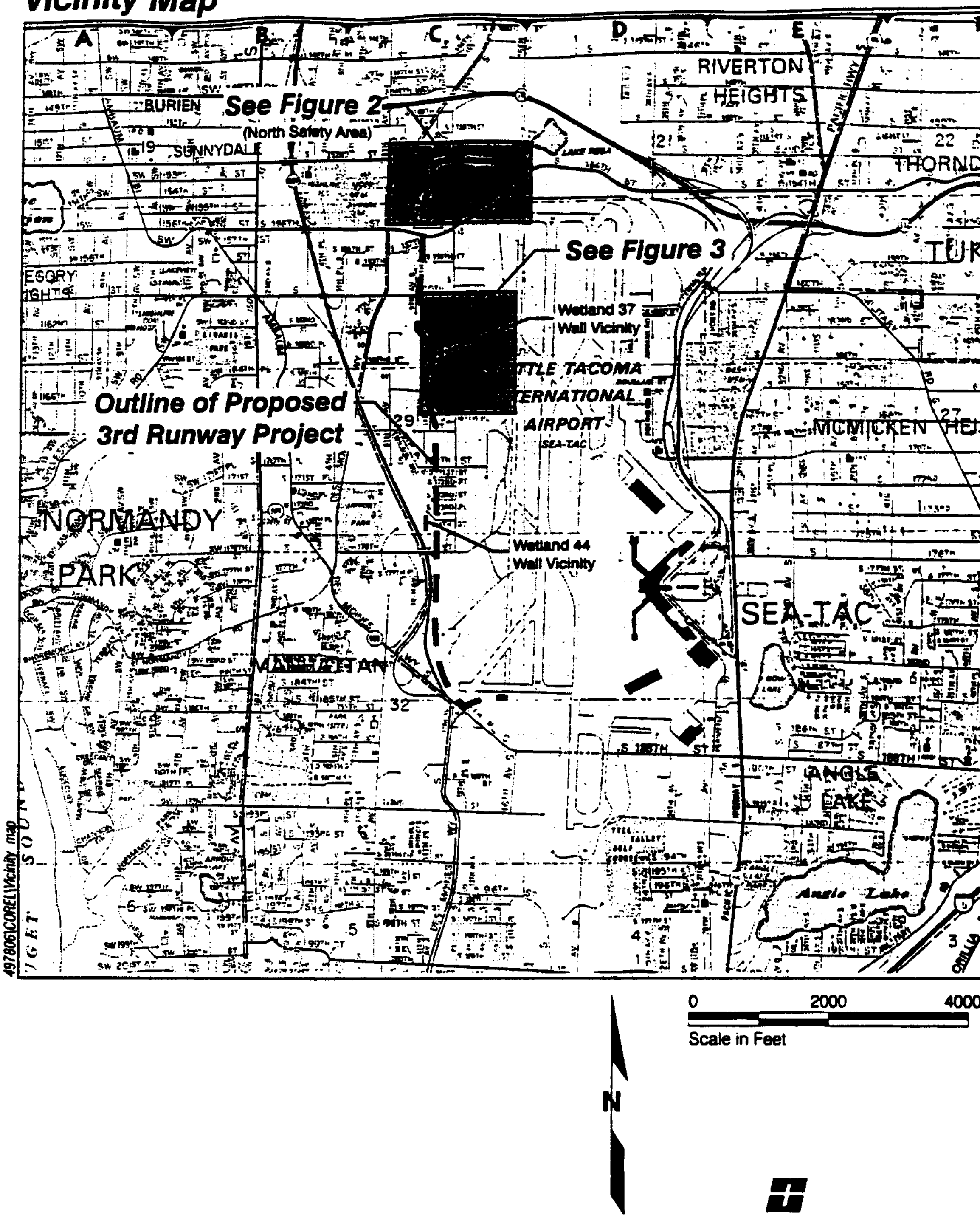

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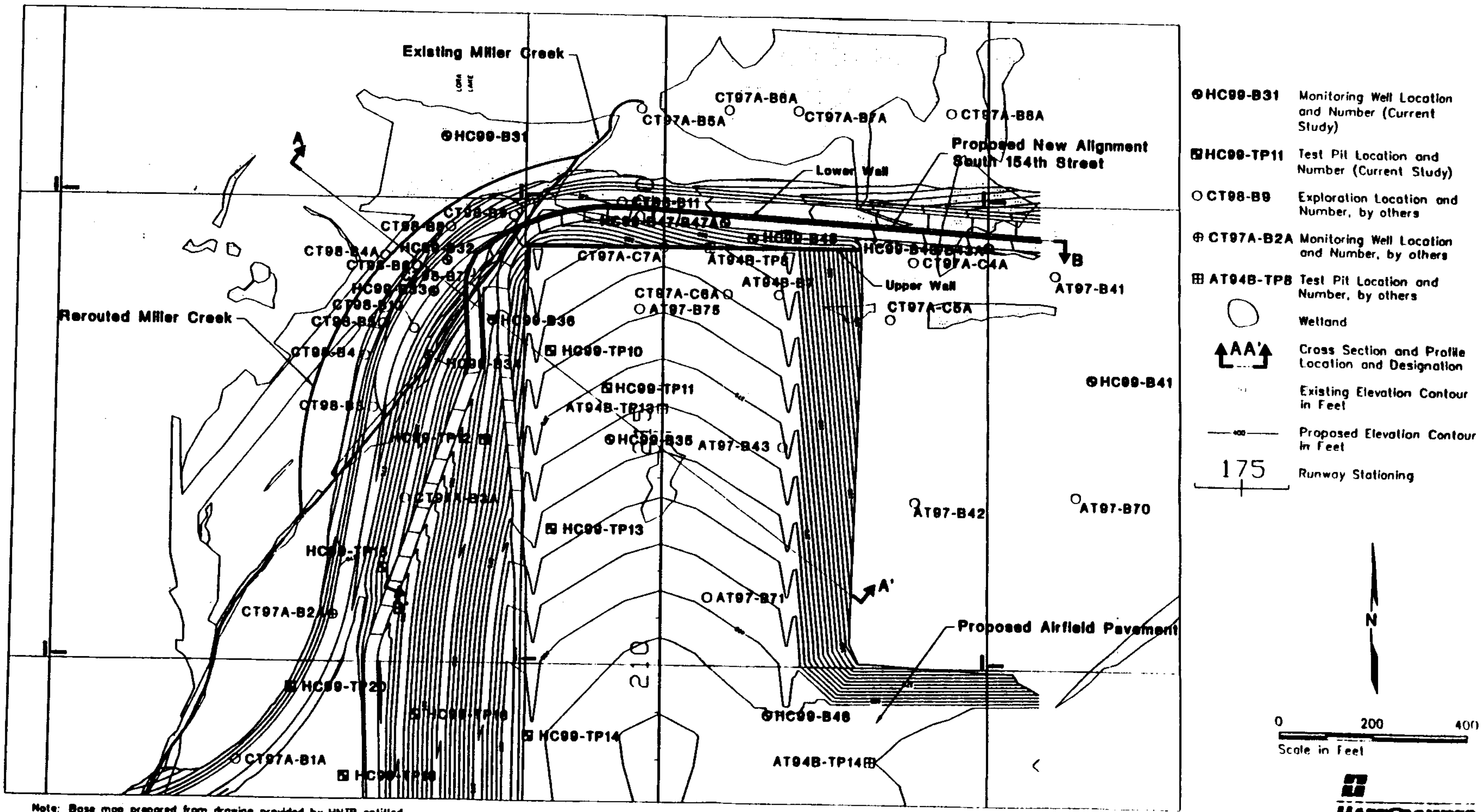
Figure 1

Site and Exploration Plan - 1 of 2

North Study Area



Note: Base map prepared from drawing provided by HNTB entitled "Sthbase.dwg", dated August, 1998. Wetland locations based on drawing provided by Parametrix entitled "w_050799.dwg", dated May 7, 1999.

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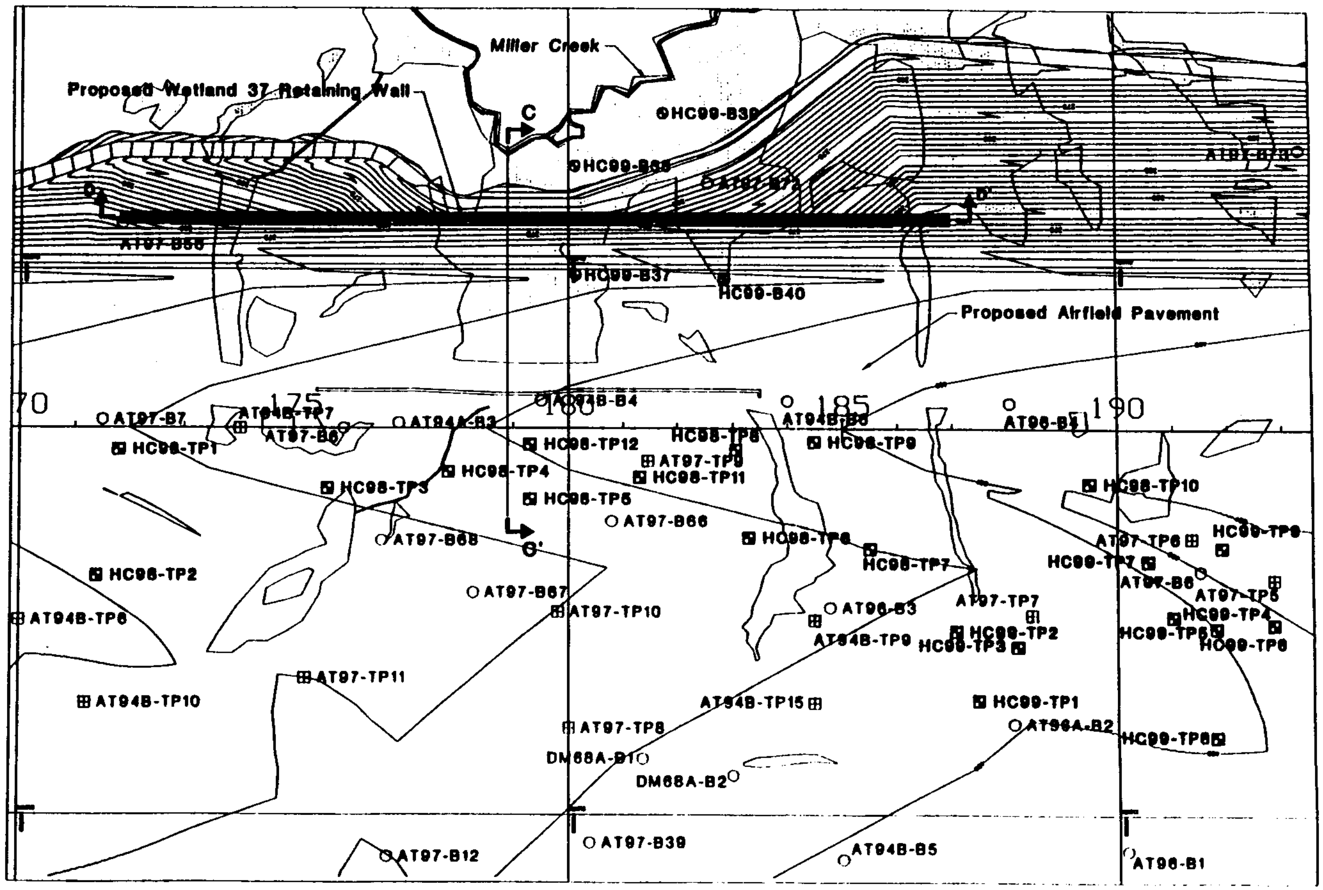
Figure 2

Site and Exploration Plan - 2 of 2

West Study Area



Note: Base map prepared from drawing provided by HNTB entitled "Sthbase.dwg", dated August, 1998. Wetland locations based on drawing provided by Parametrix entitled "w_050799.dwg", dated May 7, 1999.

- HC99-B31 — Monitoring Well Location and Number (Current Study)
- HC98-TP9 — Test Pit Location and Number (Current Study)
- CT98-B9 — Exploration Location and Number, by others
- AT97-TP6 — Test Pit Location and Number, by others
- Wetland
- AA' — Cross Section and Profile Location and Designation
- Existing Elevation Contour in Feet
- Proposed Elevation Contour in Feet
- 175 — Runway Stationing

N

0 200 400

Scale in Feet

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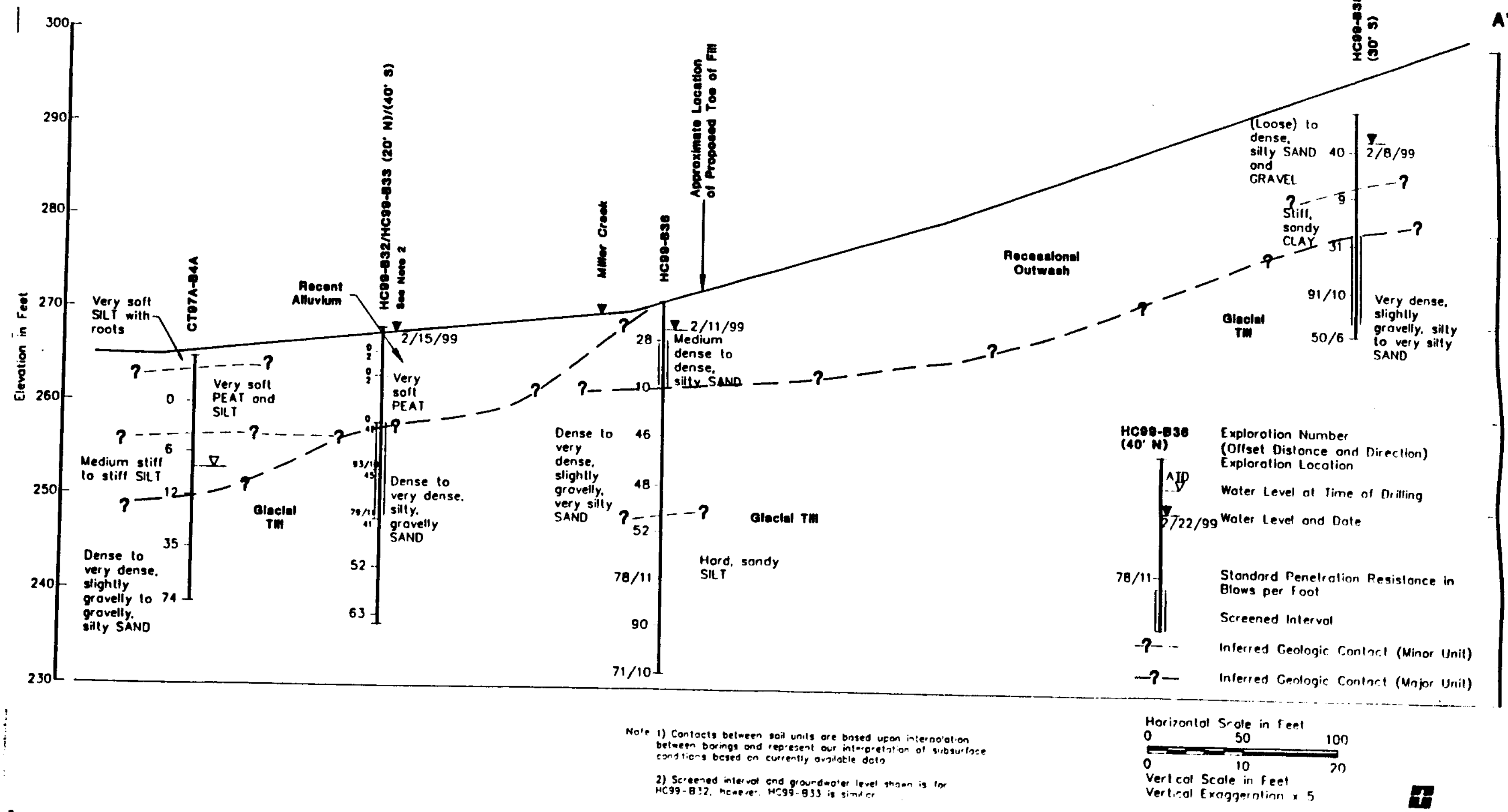
Figure 3

Generalized Geologic Cross Section A-A'
Looking Northeast



Note 1) Contacts between soil units are based upon interpolation between borings and represent our interpretation of subsurface conditions based on currently available data

2) Screened interval and groundwater level shown is for HC99-B32, however, HC99-B33 is similar

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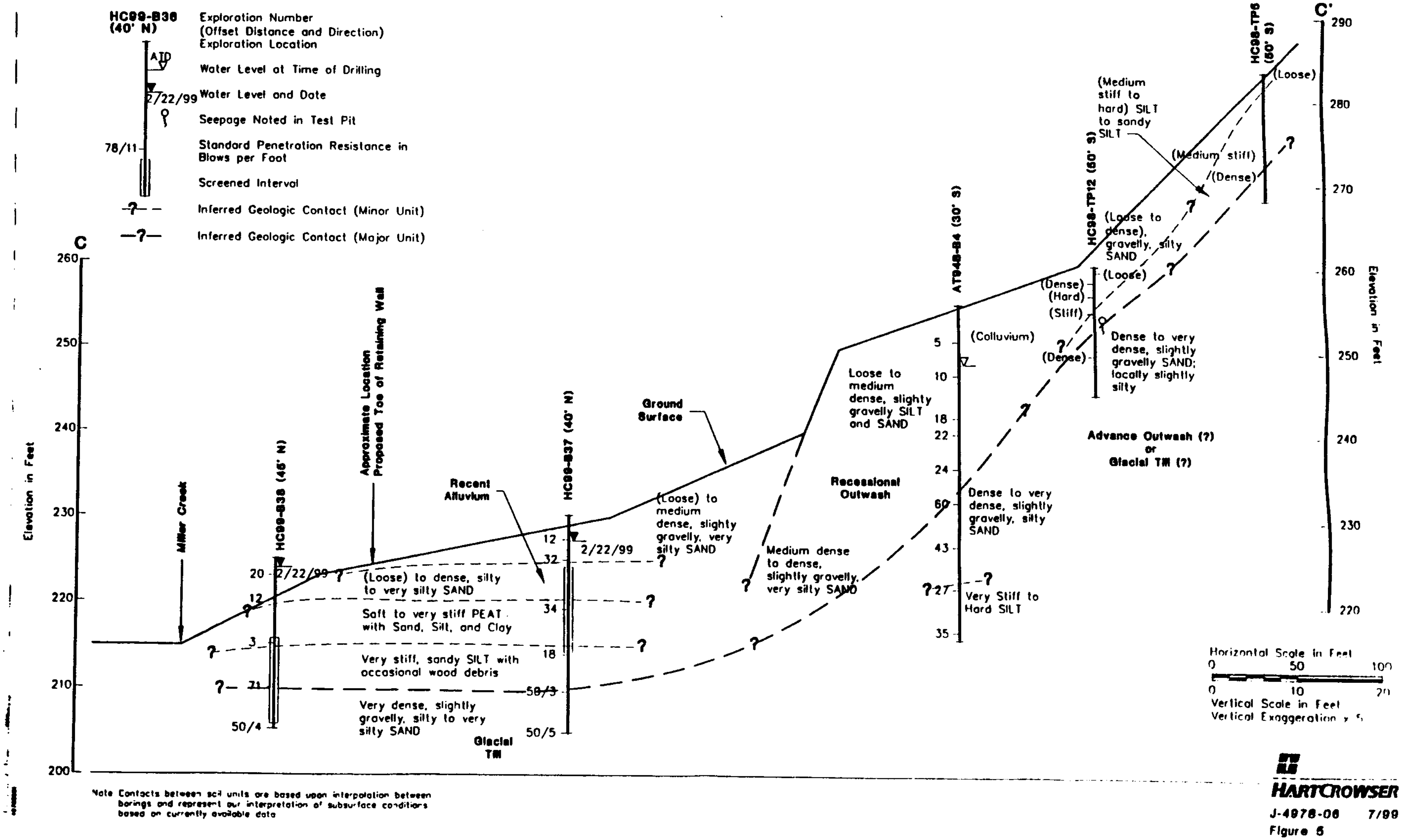
Figure 4

Generalized Geologic Cross Section C-C'
Looking North



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Generalized Geologic Profiles B-B' and D-D'

Showing Proposed Retaining Walls

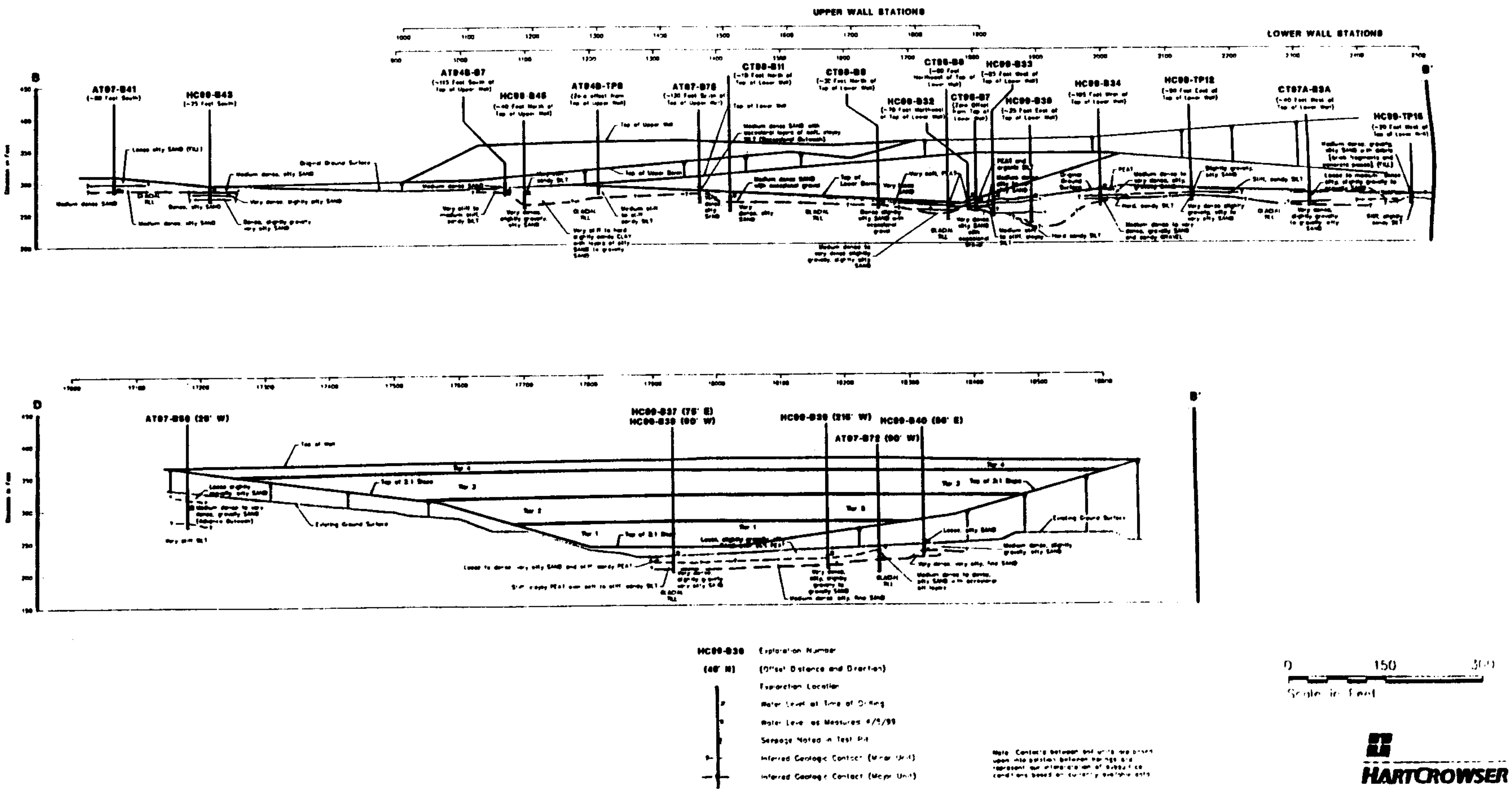

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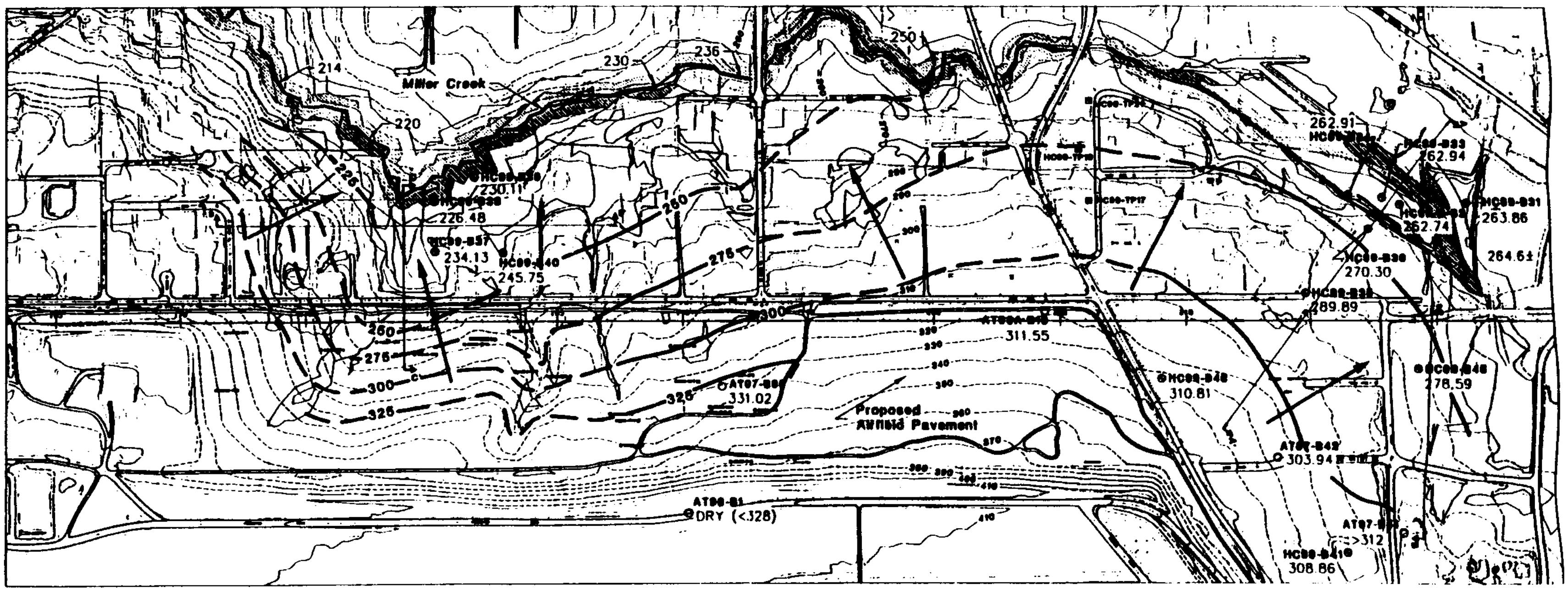
Figure 6

Shallow Regional Aquifer Groundwater Elevation Contour Map



Note: Base map prepared from drawing provided by HNTB entitled, "SthBase.dwg", dated August, 1998. Wetland locations based on drawing provided by Parametrix entitled, "w_050799.dwg," dated May 7, 1999.

300	Groundwater Elevation Contour in Feet
410	Existing Elevation Contour in Feet
●HC99-B38	Monitoring Well Location and Number
278.59	Groundwater Elevation in Feet
■HC99-TP10	Test Pit Location and Number
←	Inferred Groundwater Flow Direction
175	Runway Stationing
⬭	Wetland
A ⌐ ¬ A	Cross Section/Profile Location and Designation

N

0 400 800
Scale in Feet

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Figure 7

APPENDIX A
FIELD EXPLORATIONS METHODS AND ANALYSIS

APPENDIX A
FIELD EXPLORATIONS METHODS AND ANALYSIS

This appendix documents the processes Hart Crowser used in determining the nature of the soils underlying the project site addressed by this report. The discussion includes information on the following subjects:

- Explorations and Their Location;
- The Use of Auger Borings;
- Standard Penetration Test (SPT) Procedures;
- Use of Shelby Tubes;
- Excavation of Test Pits;
- Hydraulic Conductivity Testing (Slug Testing); and
- Water Level Measurement.

Explorations and Their Location

Subsurface explorations for this project include the following:

- **Borings**
  HC99-B31 through HC99-B41, HC99-B43, HC99-B43A, HC99-B45, HC99-B46, HC99-B47, and HC99-B47A

- **Test Pits**
  HC98-TP1 through HC98-TP12; and
  HC99-TP1 through HC99-TP21.

The exploration logs within this appendix show our interpretation of the drilling (or excavation), sampling, and testing data. They indicate the depth where the soils change. Note that the change may be gradual. In the field, we classified the samples taken from the explorations according to the methods presented on Figure A-1 - Key to Exploration Logs. This figure also provides a legend explaining the symbols and abbreviations used in the logs.

Location of Explorations. Figures 2 and 3 show the location of explorations. In the field, borings were originally located by hand taping or pacing from existing physical features. The ground surface elevations at these locations were interpreted from the aerial survey topography shown on the figures. The method used determines the accuracy of the location and elevation of the explorations.

The Use of Auger Borings

With depths ranging from 15.8 to 45.9 feet below the ground surface, fourteen hollow-stem auger borings, designated HC99-B31 through HC99-B41, HC99-B43, HC99-B43A, HC99-B45, HC99-B46, HC99-B47, and HC99-B47A were drilled from February 8 through 22, 1999, and April 19-20, 1999. The borings used a 3-3/8-inch inside diameter hollow-stem auger and were advanced with a truck-mounted drill rig subcontracted by Hart Crowser. The drilling was continuously observed by an engineering geologist from Hart Crowser. Detailed field logs were prepared of each boring. Using the Standard Penetration Test (SPT), we obtained samples at 2-1/2- to 5-foot-depth intervals.

The borings logs are presented on Figures A-2 through A-17 at the end of this appendix.

Standard Penetration Test (SPT) Procedures

This test is an approximate measure of soil density and consistency. To be useful, the results must be used with engineering judgment in conjunction with other tests. The SPT (as described in ASTM D 1587) was used to obtain disturbed samples. This test employs a standard 2-inch outside diameter split-spoon sampler. Using a 140-pound hammer, free-falling 30 inches, the sampler is driven into the soil for 18 inches. The number of blows required to drive the sampler the last 12 inches only is the Standard Penetration Resistance. This resistance, or blow count, measures the relative density of granular soils and the consistency of cohesive soils. The blow counts are plotted on the boring logs at their respective sample depths.

Soil samples are recovered from the split-barrel sampler, field classified, and placed into water tight jars. They are then taken to Hart Crowser's laboratory for further testing.

Several instances of "heave" are noted on boring logs. Heave is a phenomenon that occurs typically within a sand soil instigated by seepage pressure at the bottom of the auger (i.e., water within the augers is at a lower elevation than the groundwater level surrounding the boring). A sufficient difference in water levels will cause the sandy soils to be thrust upward into augers, thereby disturbing the soil formation. Therefore, the corresponding SPT N-values do not accurately indicate density. Heave is typically controlled by sustaining the water level within the augers at or near the surrounding groundwater level, or alternatively using drilling muds. Neither of these methods were readily available to the drilling program at the site, drilling mud could not be used under the terms of the wetland permit.

In the Event of Hard Driving

Occasionally very dense materials preclude driving the total 18-inch sample. When this happens, the penetration resistance is entered on logs as follows:

Penetration less than six inches. The log indicates the total number of blows over the number of inches of penetration.

Penetration greater than six inches. The blow count noted on the log is the sum of the total number of blows completed after the first 6 inches of penetration. This sum is expressed over the number of inches driven that exceed the first 6 inches. The number of blows needed to drive the first 6 inches are not reported. For example, a blow count series of 12 blows for 6 inches, 30 blows for 6 inches, and 50 (the maximum number of blows counted within a 6-inch increment for SPT) for 3 inches would be recorded as 80/9.

Use of Shelby Tubes

To obtain a relatively undisturbed sample for classification and testing in fine-grain soils, a 3-inch-diameter thin-walled steel (Shelby) tube sampler was pushed hydraulically below the auger. This was performed for HC99-B47 and HC99-B47A to obtain to samples from 12.5 to 15 feet (Greg, confirm??). The tubes were sealed in the field and taken to our laboratory for extrusion and classification. These samples were taken for consolidation and direct shear testing.

Excavation of Test Pits

Twelve and twenty-one test pits, designated HC98TP-1 through HC98-TP12; and HC99-TP1 through HC99-TP21, respectively, were excavated across the site with a tractor-mounted backhoe subcontracted by our firm. The '98 test pits were excavated on July 30, 1998. The '99 test pits were excavated on February 16, 1999, and April 7-12, 1999. The sides of these excavated pits offer direct observation of the subgrade soils. The test pits were located by and excavated under the direction of an engineering geologist from Hart Crowser. The geologist observed the soil exposed in the test pits and reported the findings on a field log. Our geologist took representative samples of soil types for testing at Hart Crowser's laboratory. He noted groundwater levels or seepage during excavation. The density/consistency of the soils (as presented parenthetically on the test pit logs to indicate their having been estimated) is based on visual observation only as disturbed soils cannot be measured for in-place density in the laboratory.

AR 042552

The test pit logs are presented on Figures A-18 through A-34.

Hydraulic Conductivity Testing (Slug Testing)

Hydraulic conductivity testing was performed using the slug test method. In this method the water level (hydraulic head) in the well is rapidly raised or lowered, and the rate at which it returns to its initial state is used to calculate hydraulic conductivity for the formation surrounding the wellscreen. Data were collected using an Aquistar data logger in conjunction with a Instrumentation Northwest PSI9000 pressure transducer. Tests were conducted as follows:

- A transducer was set in the well and allowed to equilibrate with ambient conditions, and background water level data were collected.
- One or two slug rods (solid PVC rods) were rapidly introduced into the well (causing a near-instantaneous rise in water level), to initiate a falling head test. Water level data were collected in logarithmically increasing time increments using the data logger and transducer. For wells where depth to water was small, a falling head test was not attempted.
- Water level in the well was allowed to re-equilibrate.
- The slug rod or rods were rapidly pulled from the well (causing a near-instantaneous drop in water level) to initiate a rising head test. Water level data were collected in logarithmically increasing time increments using the data logger and transducer.
- Most of the wells responded reasonably quickly, and therefore multiple slug tests were performed for most wells.

Data were pre-processed as described in Butler (1998), and hydraulic conductivity values were estimated using the method of Bouwer and Rice (1976) for unconfined aquifers. The estimated values are summarized in Table 1.

Water Level Measurement

Water levels were measured using a Solinst water level probe, graduated in 0.01-foot increments. Depth to water was measured below the top of casing, and recorded to the nearest hundredth of a foot. Depth to water was converted to groundwater elevation using survey information for the top of casing in the wells. Depth to water data and groundwater elevations are summarized in Table 2.

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Key to Exploration Logs

Sample Description

Classification of soils in this report is based on visual field and laboratory observations which include density/consistency, moisture condition, grain size, and plasticity estimates and should not be construed to imply field nor laboratory testing unless presented herein. Visual-manual classification methods of ASTM D 2488 were used as an identification guide.

Soil descriptions consist of the following:
Density/consistency, moisture, color, minor constituents, MAJOR CONSTITUENT, additional remarks.

Density/Consistency

Soil density/consistency in borings is related primarily to the Standard Penetration Resistance.
Soil density/consistency in test pits is estimated based on visual observation and is presented parenthetically on the test pit logs.

SAND or GRAVEL Density	Standard Penetration Resistance (N) in Blows/Foot	SILT or CLAY Consistency	Standard Penetration Resistance (N) in Blows/Foot	Approximate Shear Strength in TSF
Very loose	0 – 4	Very soft	0 – 2	<0.125
Loose	4 – 10	Soft	2 – 4	0.125 – 0.25
Medium dense	10 – 30	Medium stiff	4 – 8	0.25 – 0.5
Dense	30 – 50	Stiff	8 – 15	0.5 – 1.0
Very dense	>50	Very stiff	15 – 30	1.0 – 2.0
		Hard	>30	>2.0

Moisture

Dry	Little perceptible moisture
Damp	Some perceptible moisture, probably below optimum
Moist	Probably near optimum moisture content
Wet	Much perceptible moisture, probably above optimum

Minor Constituents

	Estimated Percentage
Not identified in description	0 – 5
Slightly (clayey, silty, etc.)	5 – 12
Clayey, silty, sandy, gravelly	12 – 30
Very (clayey, silty, etc.)	30 – 50

Legends

Sampling Test Symbols

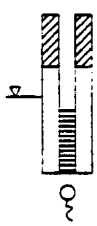
BORING SAMPLES

- ⊠ Split Spoon
- Shelby Tube
- Cuttings
- Core Run
- * No Sample Recovery
- P Tube Pushed, Not Driven

TEST PIT SAMPLES

- ⊠ Grab (Jar)
- Bag
- Shelby Tube

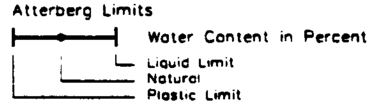
Groundwater Observations



- Surface Seal
- Groundwater Level on Date (ATD) At Time of Drilling
- Observation Well Tip or Slotted Section
- Groundwater Seepage (Test Pits)

Test Symbols

NS	No Sheen
SS	Slight Sheen
MS	Moderate Sheen
HS	Heavy Sheen
TCD	Triaxial Consolidated Drained
QU	Unconfined Compression
DS	Direct Shear
K	Permeability
PP	Pocket Penetrometer Approximate Compressive Strength in TSF
TV	Torvane Approximate Shear Strength in TSF
CBR	California Bearing Ratio
MD	Moisture Density Relationship
AL	Atterberg Limits
PID	Photoionization Detector Reading
CA	Chemical Analysis
DT	In Situ Density Test



1=1 BORING DWG

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Figure A-1

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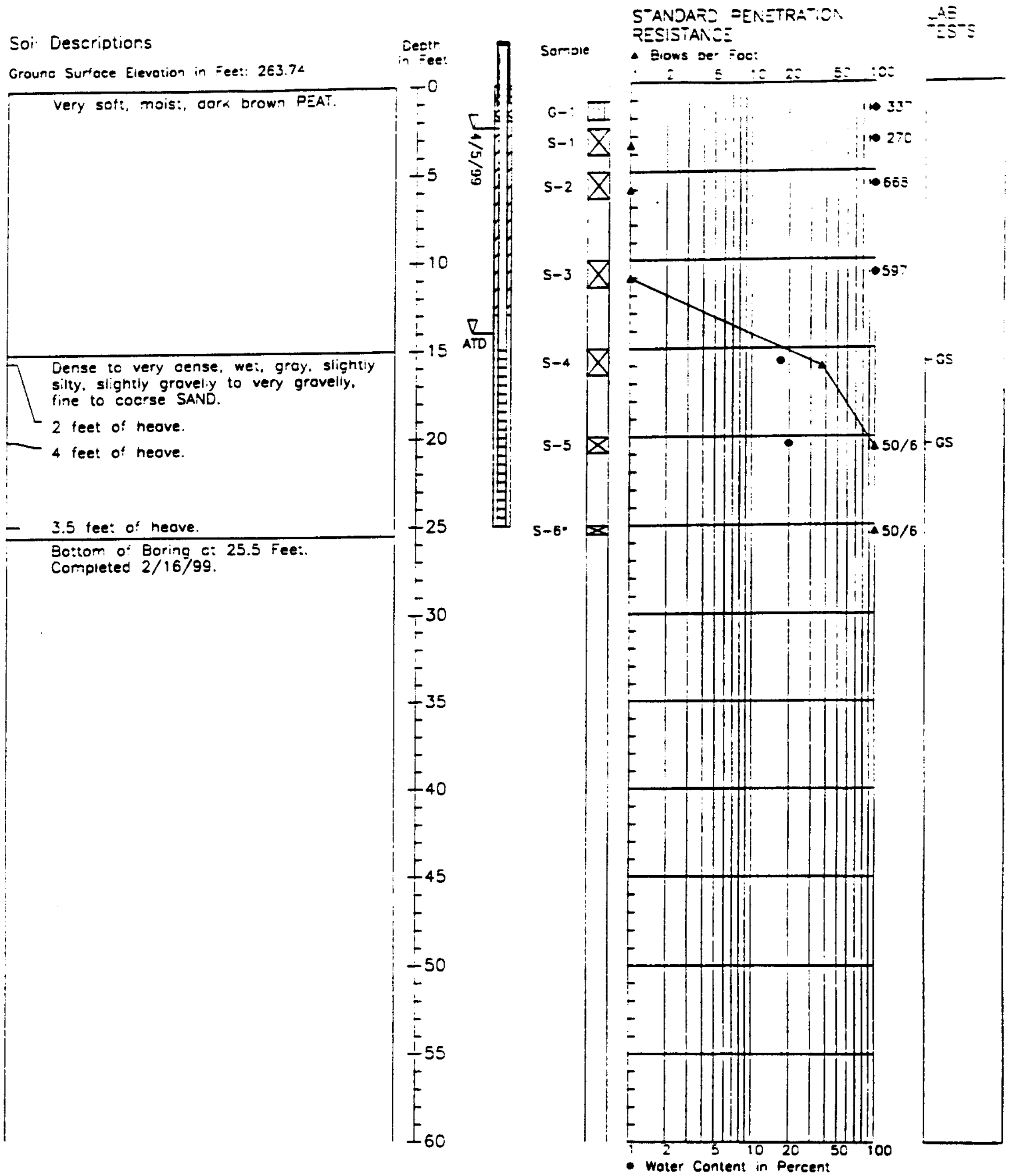
Boring Log HC99-B31

N 10,827.55, E 22,134.13



1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

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Figure A-2

CVD 7/27/99 1=1 WDSTK-BPC2
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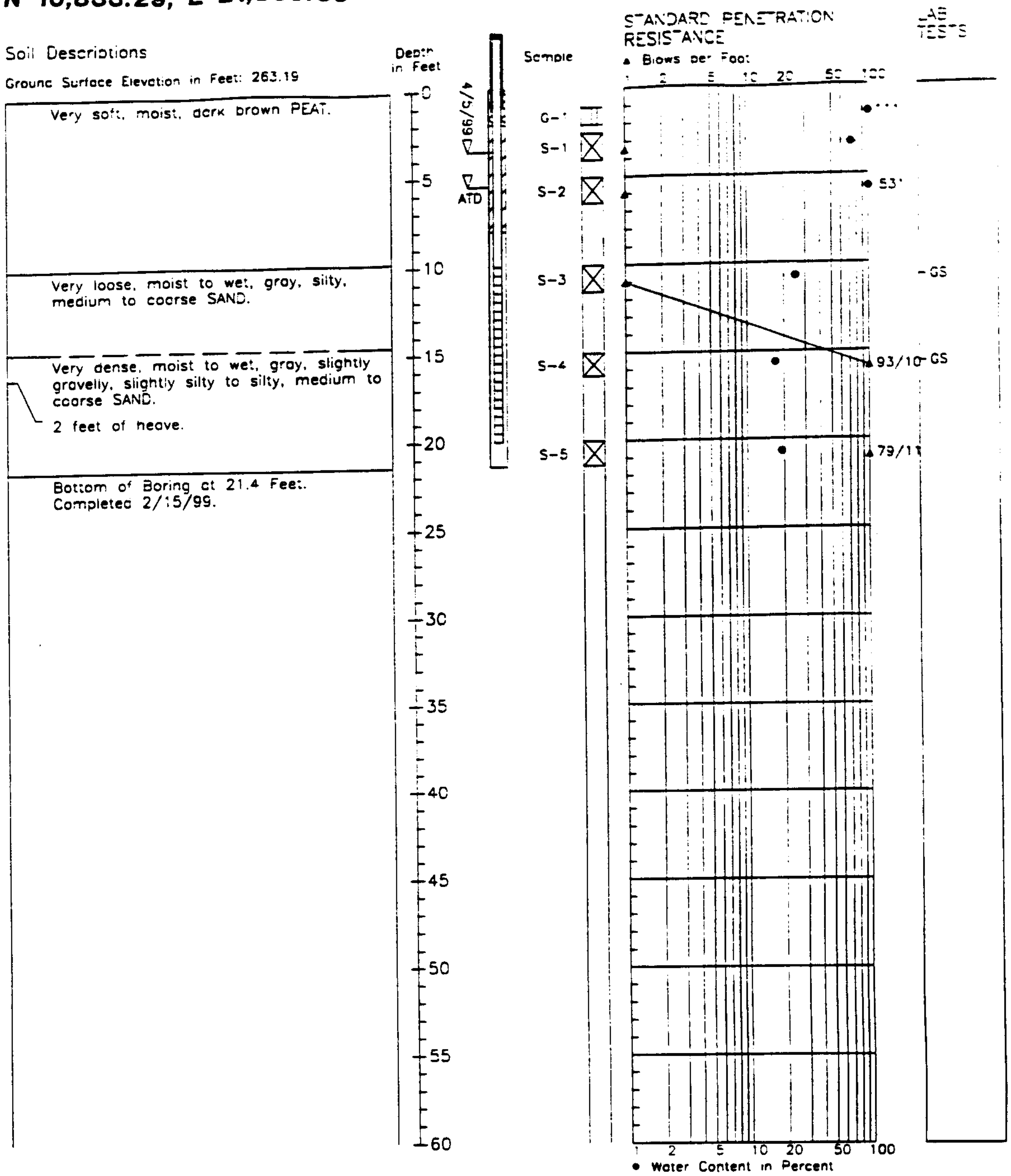
Boring Log HC99-B32

N 10,833.29, E 21,865.35



1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

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Figure A-3

AR 042557

Boring Log HC99-B33

N 10,805.28, E 21,797.16

Soil Descriptions

Ground Surface Elevation in Feet: 262.75

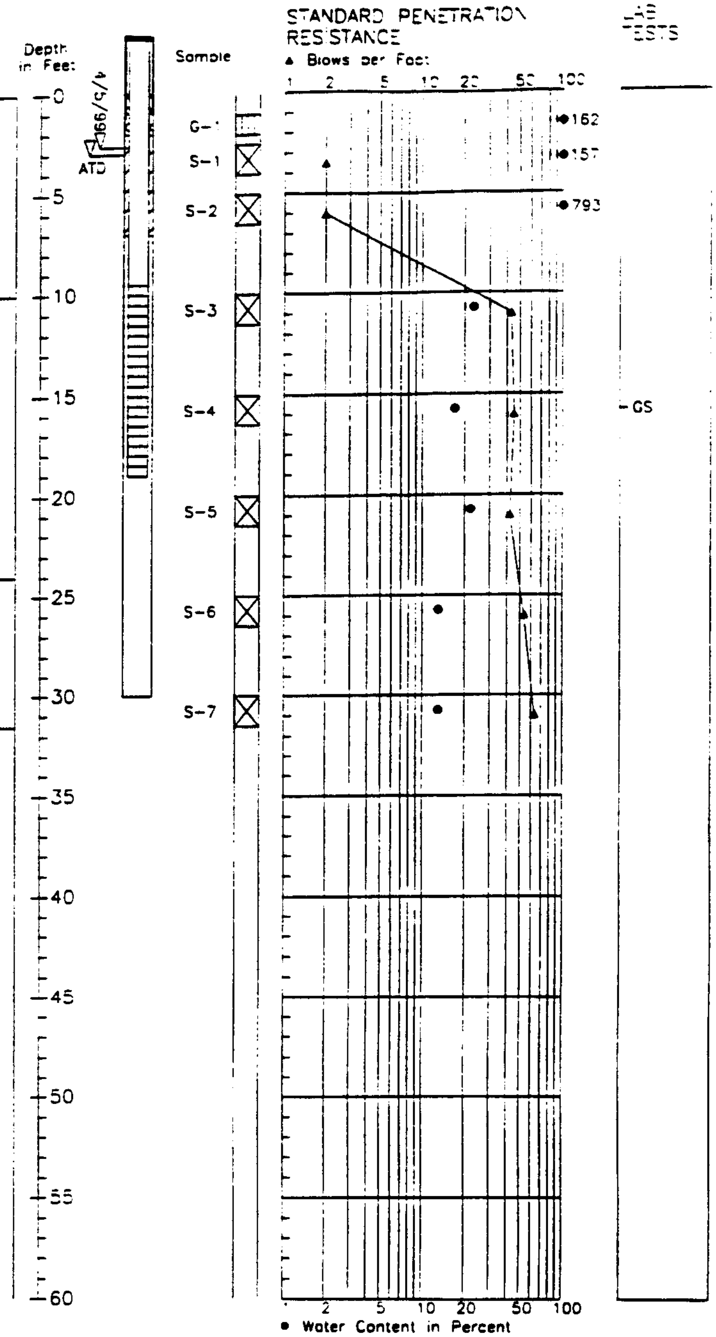
Very soft, moist, dark brown PEAT.

Dense, wet, gray, slightly silty, slightly gravelly, medium to coarse SAND.

Very dense, wet, gray, slightly gravelly, silty SAND.

2 feet of heave.

Bottom of Boring at 31.5 Feet.
Completed 2/15/99.



1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

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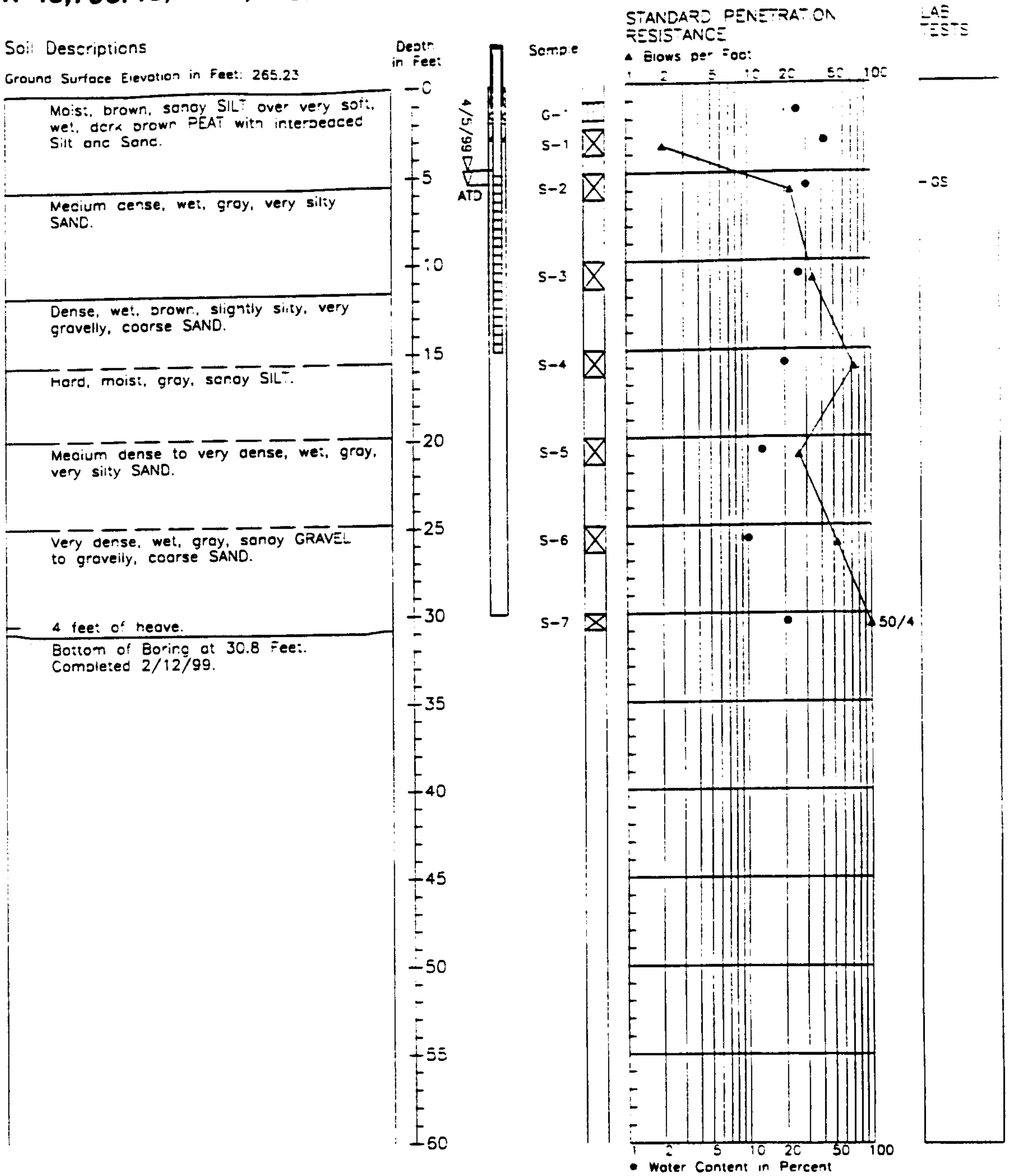
Figure A-4

AR 042558

Boring Log HC99-B34

N 10,796.45, E 21,659.37



1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

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Figure A-5

AR 042559

Boring Log HC99-B35

N 11,188.88, E 21,481.49

Soil Descriptions

Ground Surface Elevation in Feet: 292.58

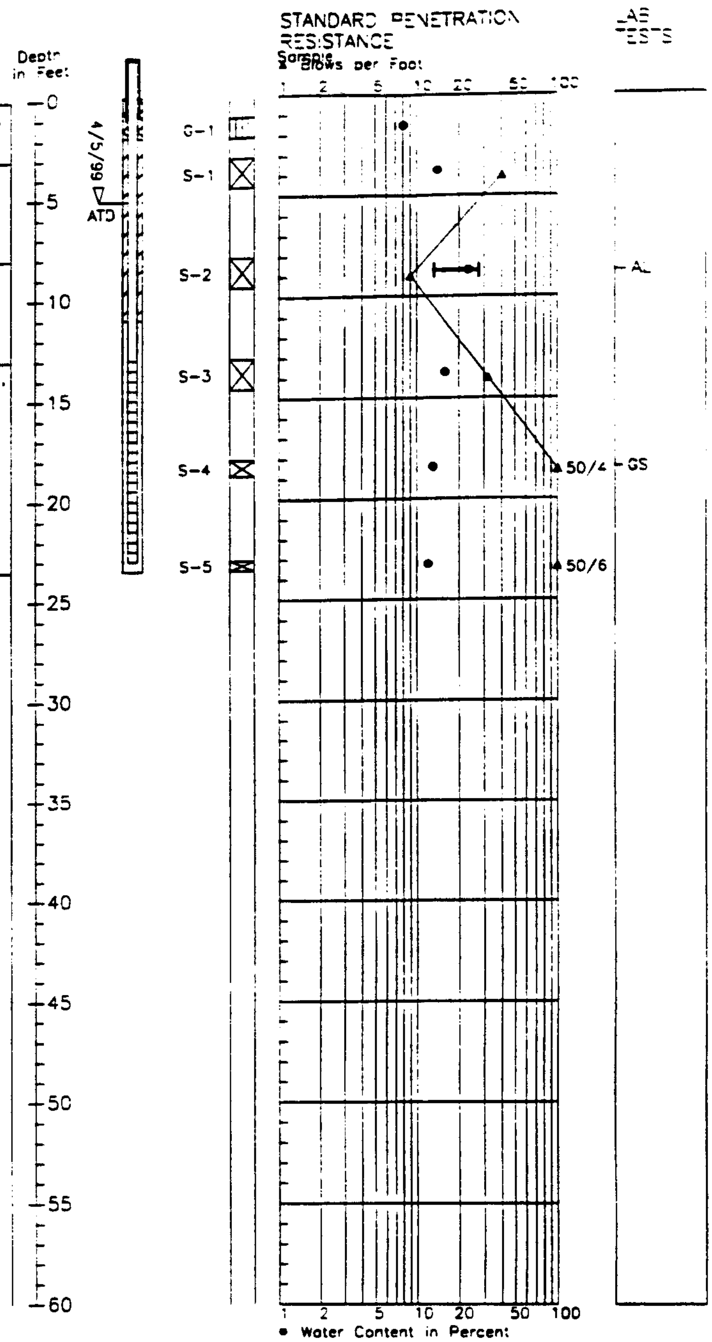
6 inches of TOPSOIL over (loose), moist, brown, sandy GRAVEL.

Dense, wet, gray to brown, slightly silty, gravelly SAND.

Stiff, damp, gray, slightly sandy CLAY.

Dense to very dense, moist to wet, gray, slightly gravelly, very silty SAND.

Bottom of Boring at 23.5 Feet.
Completed 2/8/99.



1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

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Figure A-6

Boring Log HC99-B36

N 10,932.10, E 21,736.5

Soil Descriptions

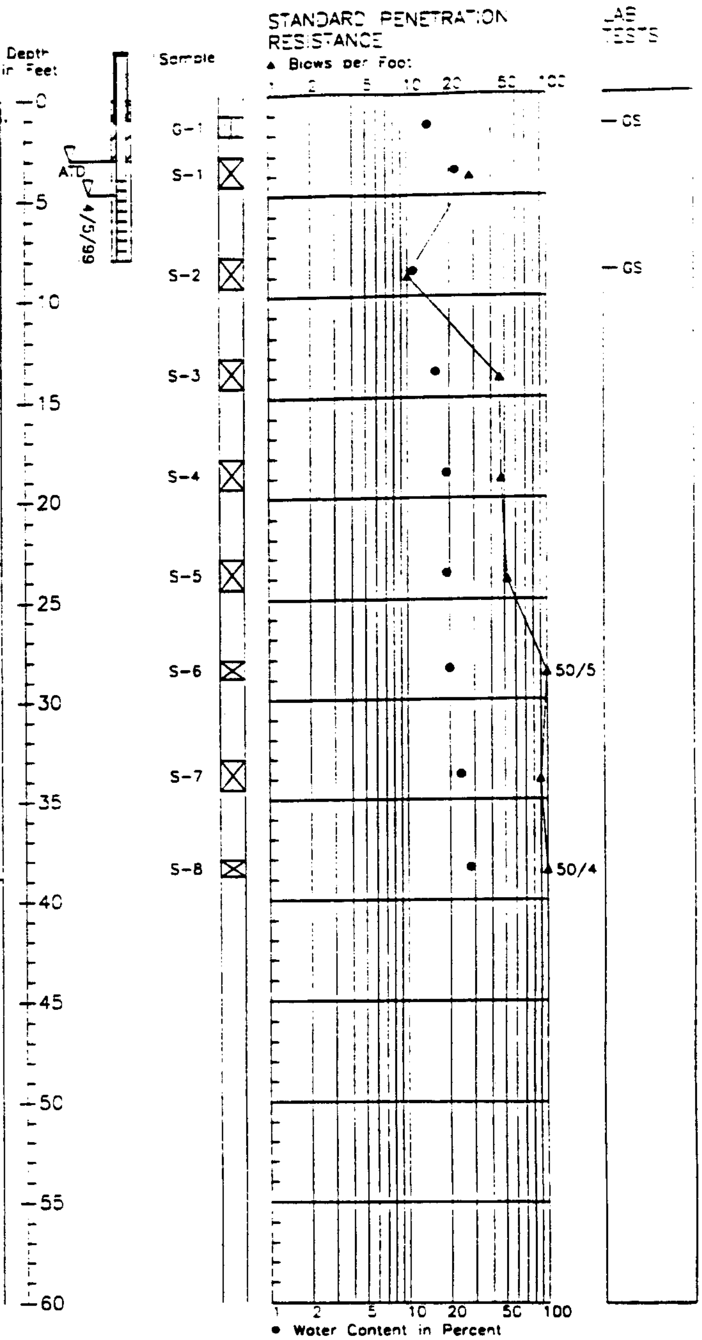
Ground Surface Elevation in Feet: 272.63

(Loose) to medium dense, damp to moist, brown, very silty SAND.

Medium dense to dense, moist, gray, slightly gravelly to gravelly, very silty SAND.

Hard, damp to moist, gray, sandy SILT.

Bottom of Boring at 38.5 Feet.
Completed 2/8/99.



1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

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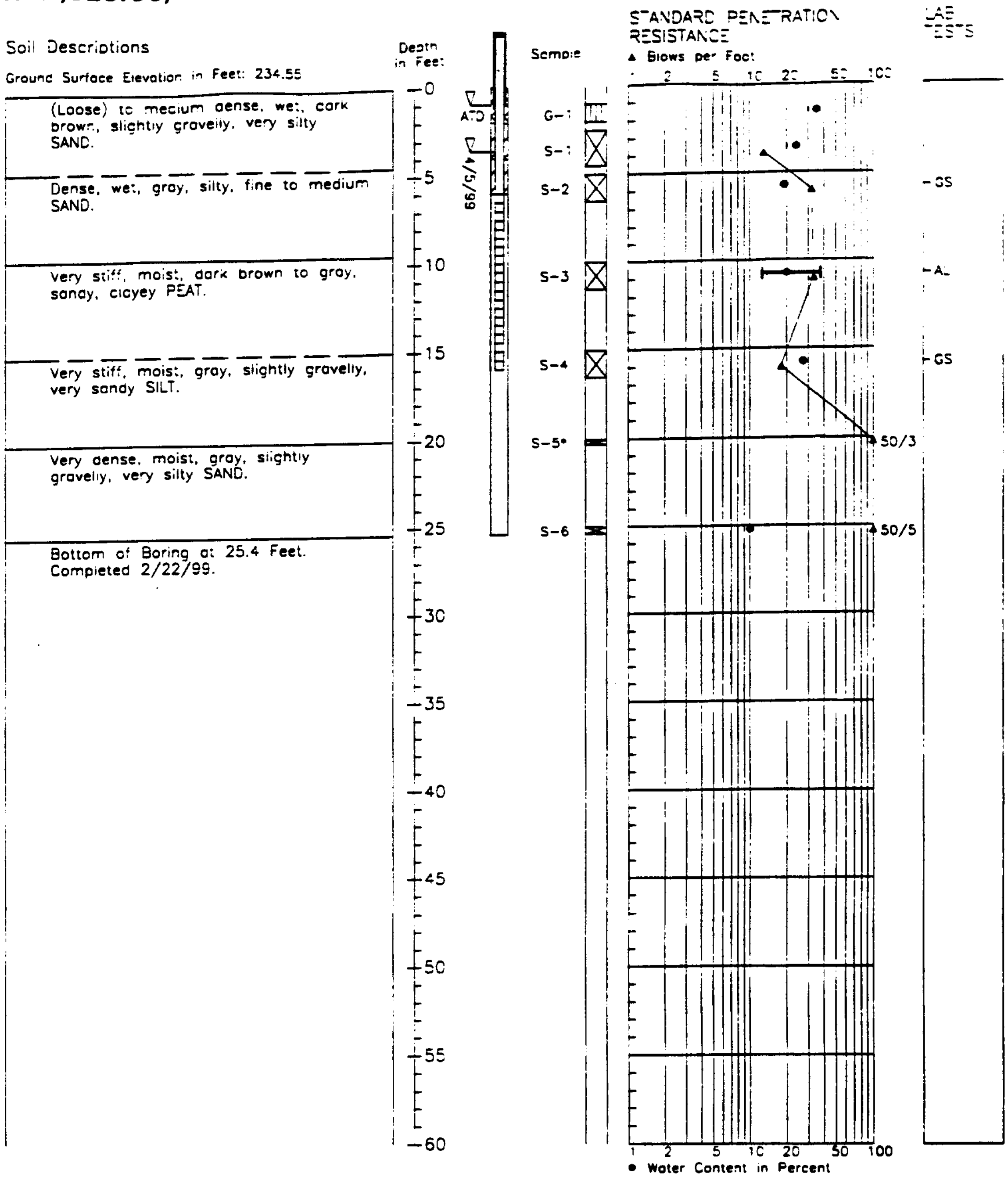
Figure A-7

Boring Log HC99-B37

N 11,020.06, E 18,013.81



1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

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Figure A-8

Boring Log HC99-B38

N 10,819.39, E 18,011.99

Soil Descriptions

Ground Surface Elevation in Feet: 227.58

(Loose), moist, brown, silty SAND.

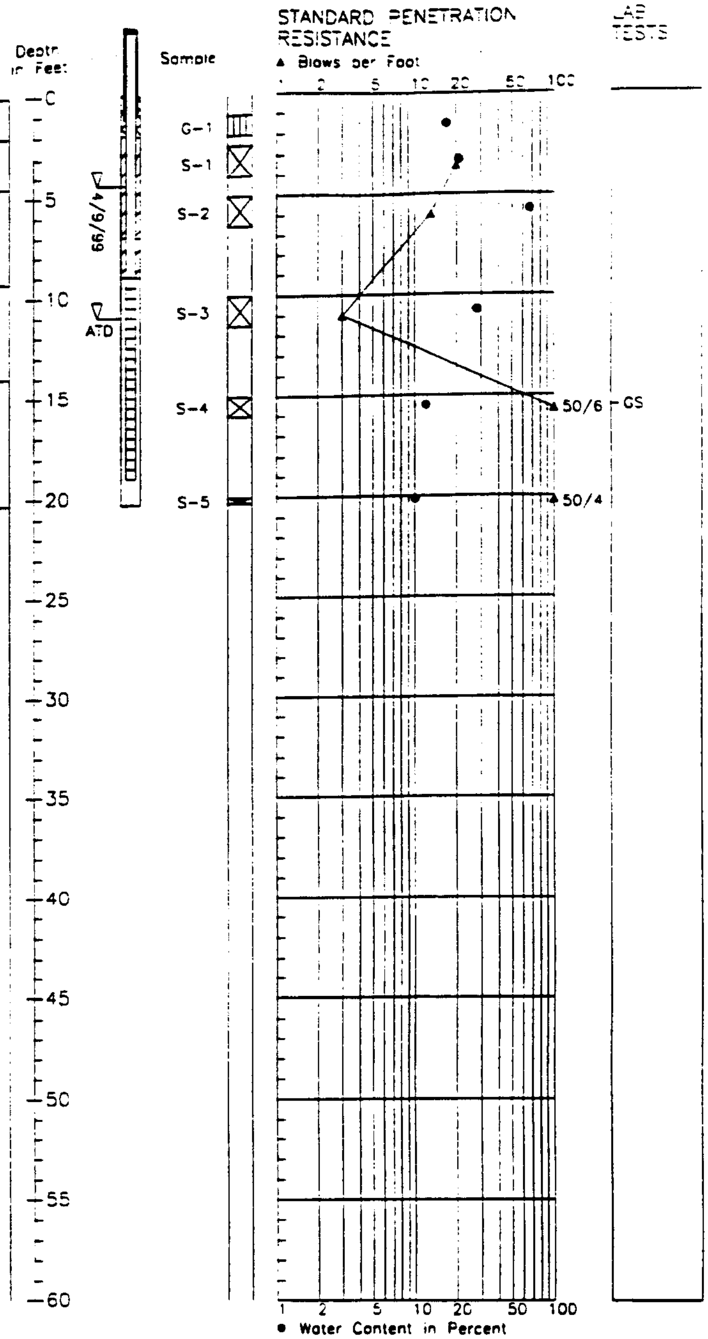
Medium dense, moist, gray, very silty SAND.

Stiff, moist, dark brown, sandy PEAT with occasional wood debris.

Soft, moist, gray, slightly sandy SILT with occasional wood debris.

Very dense, moist to wet, gray, slightly gravelly, silty SAND.

Bottom of Boring at 20.3 Feet. Completed 2/22/99.



1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

CVD 7/27/99 1=1 WDSIK-8 PC2
4978\LOGS\99 BORINGS

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Figure A-9

Boring Log HC99-B39

N 10,722.31, E 18,174.14

Soil Descriptions

Ground Surface Elevation in Feet: 231.10

6 inches of TOPSOIL over very loose, moist, brown and gray, slightly gravelly, silty SAND.

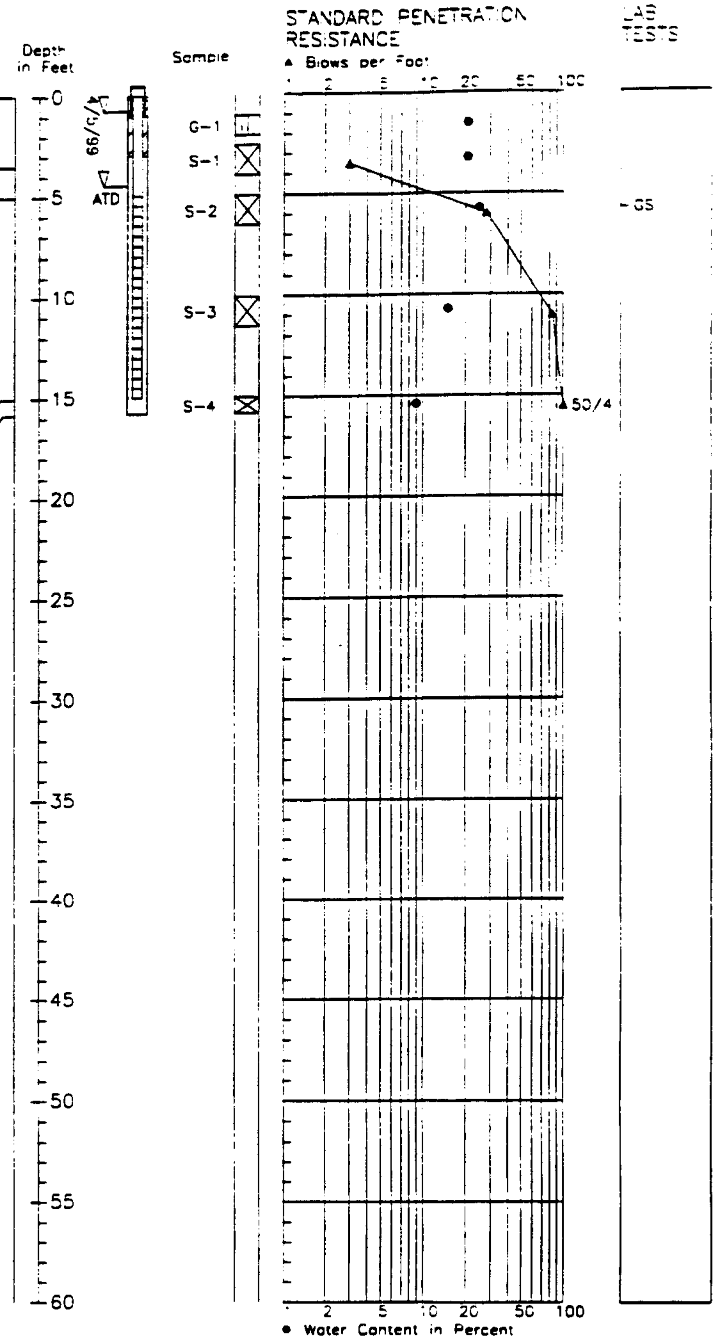
Soft, moist, brown PEAT.

Medium dense to very dense, moist, gray, silty, fine SAND.

8-inch layer of silty CLAY.

Very dense, moist, gray, silty, gravelly SAND.

Bottom of Boring at 15.8 Feet.
Completed 2/16/99.



1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

CVD 7/27/99 1=1 WDSIK-BPC2
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Figure A-10

AR 042564

Boring Log HC99-B40

N 11,025.60, E 18,285.23

Soil Descriptions

Ground Surface Elevation in Feet: 248.63

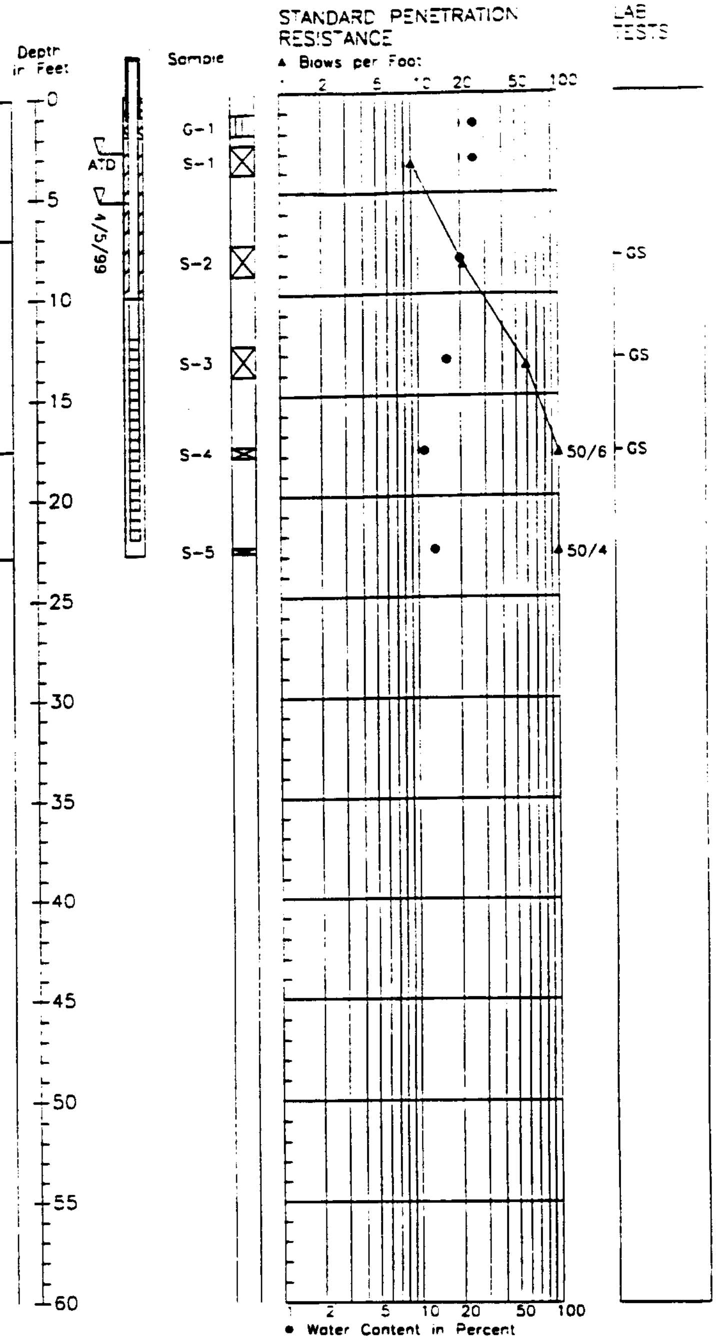
Loose, wet, dark brown, slightly gravelly, silty SAND.

Medium dense to very dense, wet, gray, slightly gravelly, silty SAND.

Cobbly drill action.

Very dense, moist, gray, very silty, fine SAND.

Bottom of Boring at 22.8 Feet.
Completed 2/9/99.



1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

CVD 7/27/99 1=1 WDSTK 8.PC2
4978\DGS\99 BORINGS

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Figure A-11

Boring Log HC99-B41

N 12,222.85, E 21,624.38

Soil Descriptions

Ground Surface Elevation in Feet: 337.93

Medium dense, moist, brown WOOD DEBRIS. (FILL)

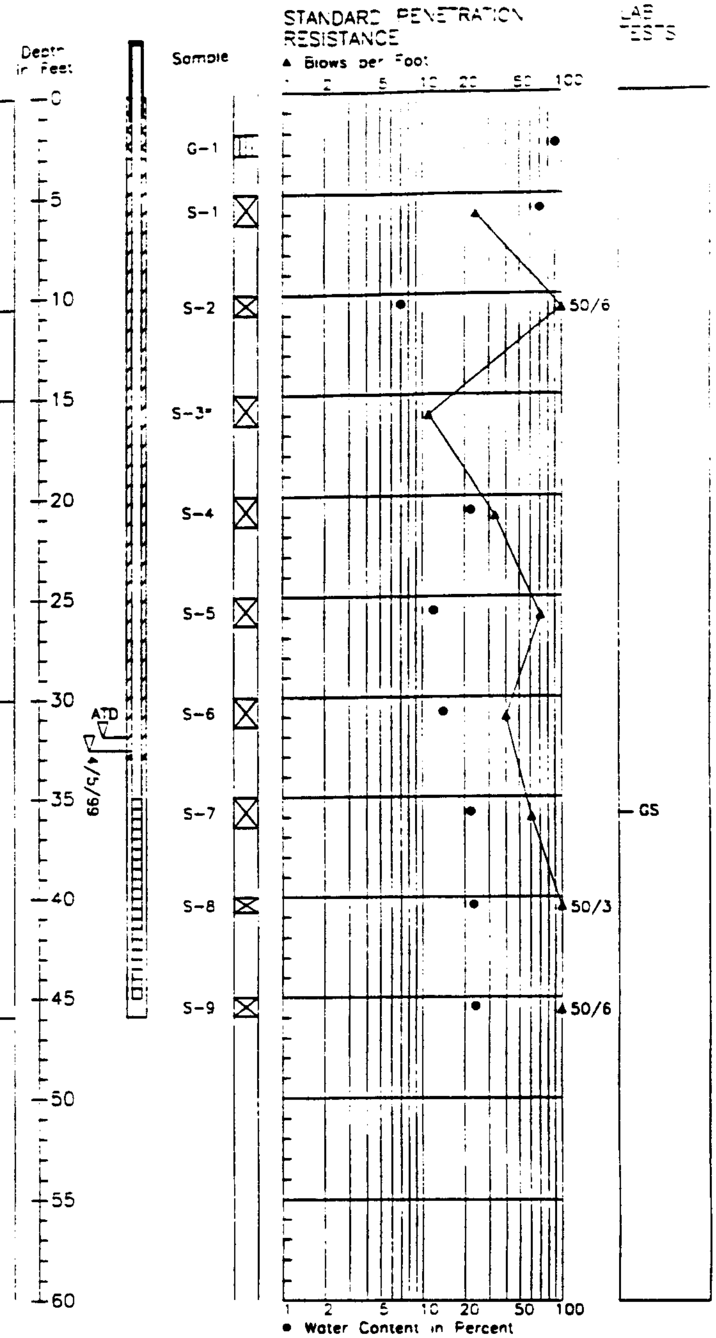
Very dense, damp, gray, slightly silty, very gravelly SAND.

Hard, moist, brown mottled orange and gray, slightly gravelly, sandy SILT.

Dense to very dense, moist to wet, brown and gray, slightly silty to very silty SAND.

Petroleum-like odor detected in Sample S-7

Bottom of Boring at 45.9 Feet. Completed 2/10/99.



1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

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Figure A-12

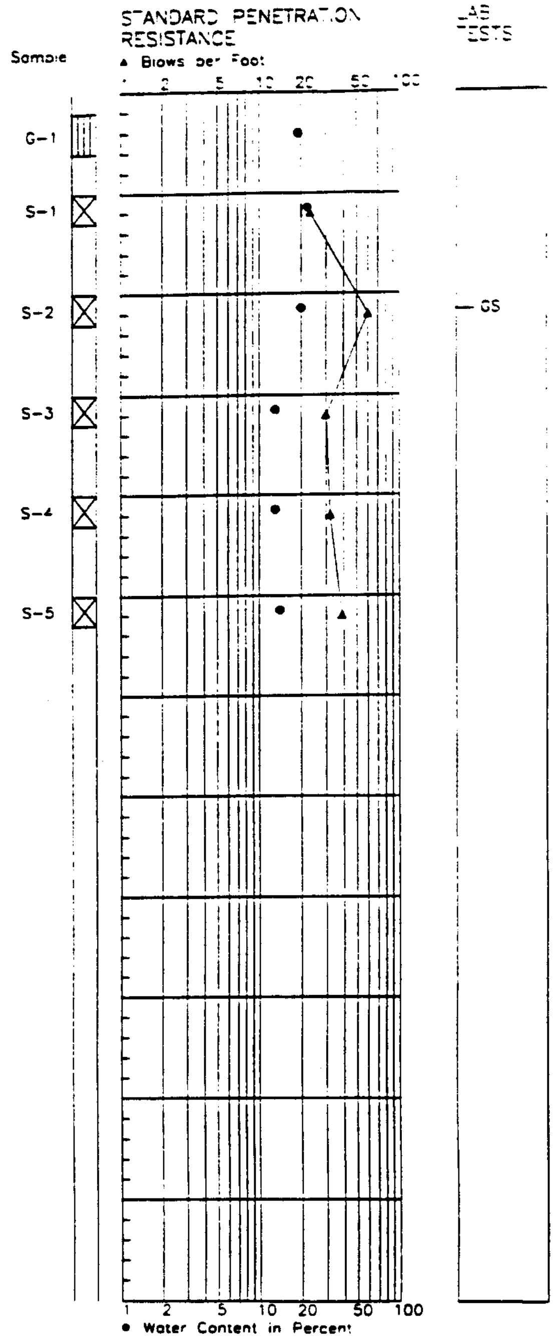
CVD 7/27/99 1=1 WDSIK-BPC2
4978\GCS\99 BORINGS

AR 042566

Boring Log HC99-B43

N 12,000.13, E 21,908.63

Soil Descriptions	Depth in Feet
Ground Surface Elevation in Feet: 292 (Approximate)	0
Medium dense, moist to wet, brown, silty to very silty, fine to medium SAND.	0
Very dense, wet, gray, slightly silty, medium SAND. Petroleum-like odor detected in Sample S-2	10
Dense, moist, brown, slightly gravelly, very silty SAND.	15
Artesian conditions.	25
Dense, wet, brown, silty SAND.	25
6 feet of heave.	30
Bottom of Boring at 30 Feet. Completed 2/11/99.	30



1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

CVD 7/27/99 1=1 WDSIK-BPC2
4978\LOGS\99 BORINGS

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Figure A-13

AR 042567

Boring Log HC99-B43A

N 11,998.17, E 21,914.80

Soil Descriptions

Ground Surface Elevation in Feet: 292.58

Loose, damp to moist, dark brown, gravelly, silty SAND with occasional wood debris.

Medium dense, wet, gray, slightly gravelly, fine to medium SAND.

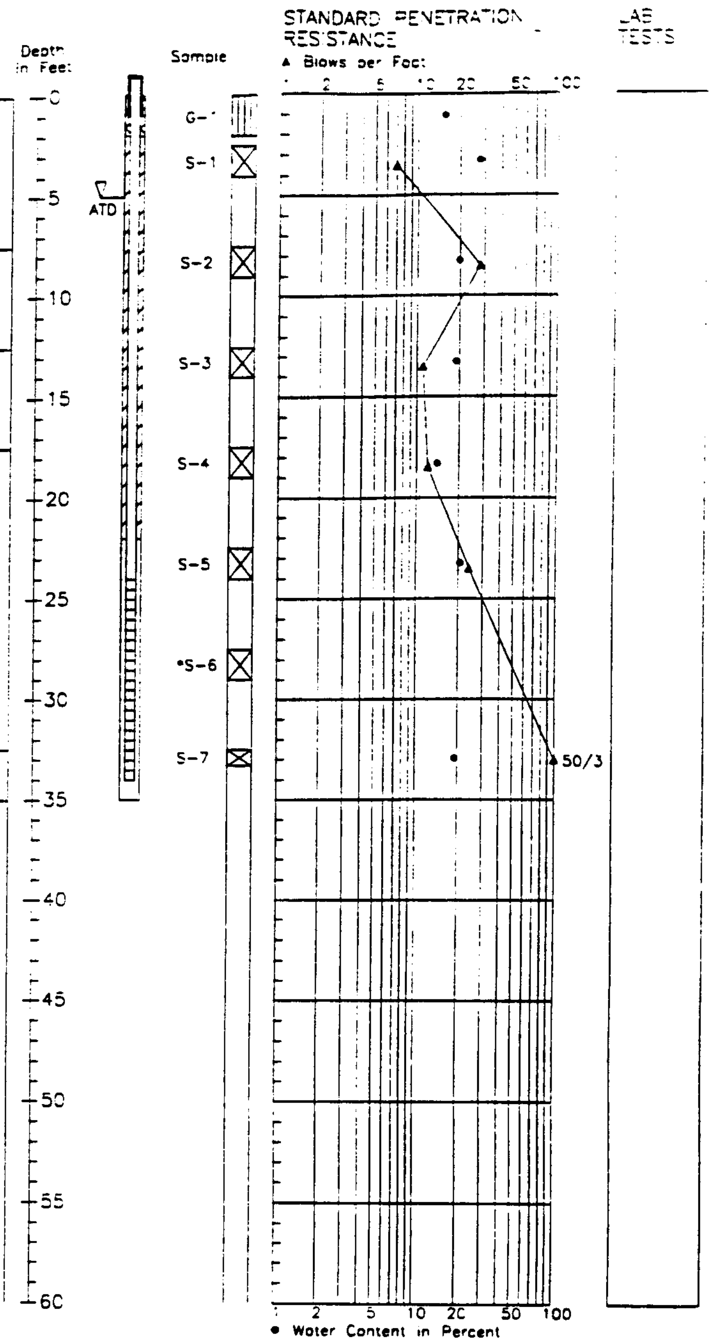
Stiff, moist to wet, tan, sandy SILT.

Medium dense to very dense, wet, gray to brown, slightly silty SAND.

Artesian conditions.

Hard, wet, brown to tan, sandy SILT.

Bottom of Boring at 35 Feet.
Completed 4/19/99.



1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

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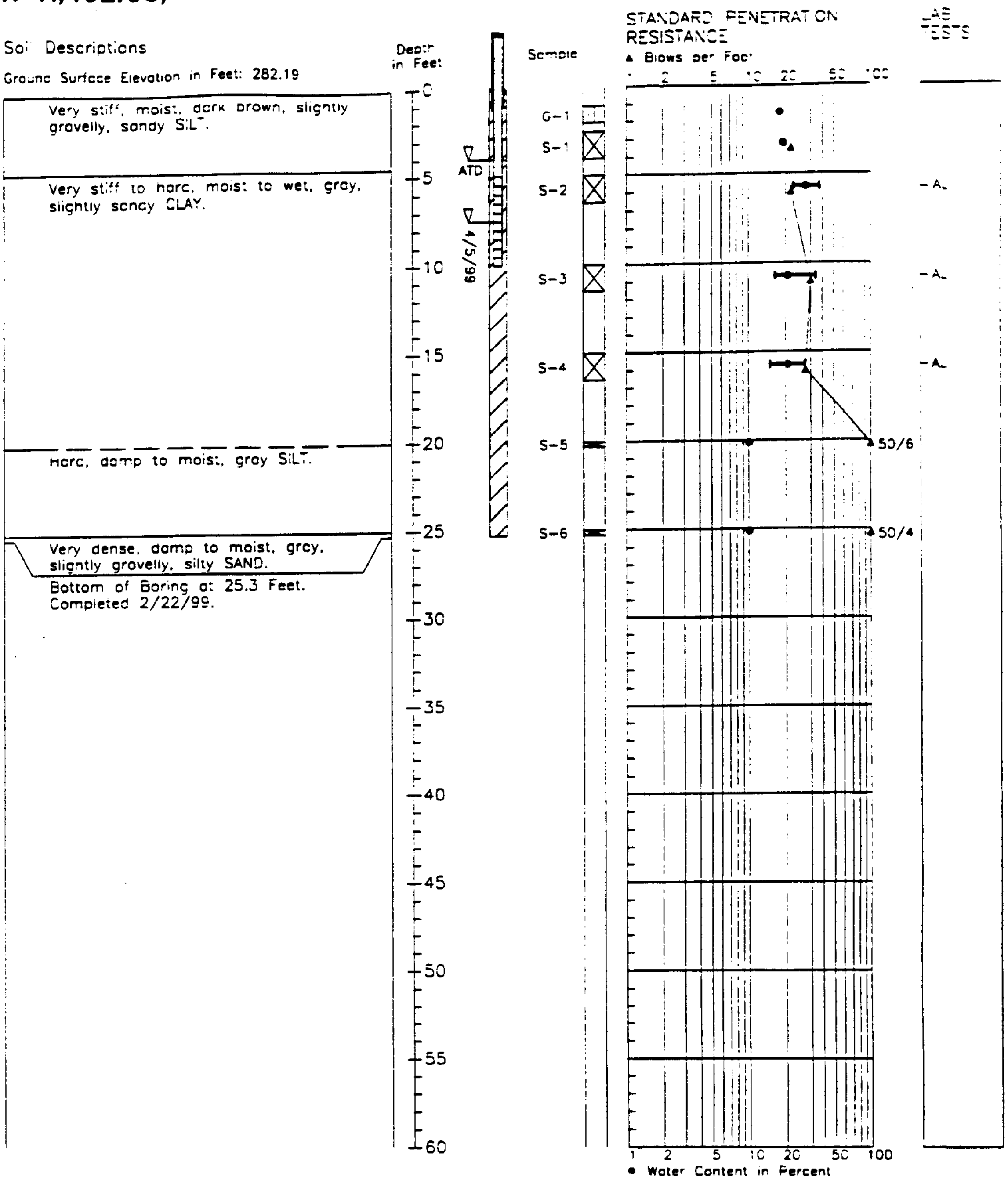
Figure A-14

CVD 7/27/99 1=1 WDSTK 8PC2
4978\LOGS\99 BORINGS

AR 042568

Boring Log HC99-B45

N 11,492.55, E 21,921.99



1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

CVD 7/27/99 1=1 WDS1K-RPC2
4978\LOGS\99 BORINGS

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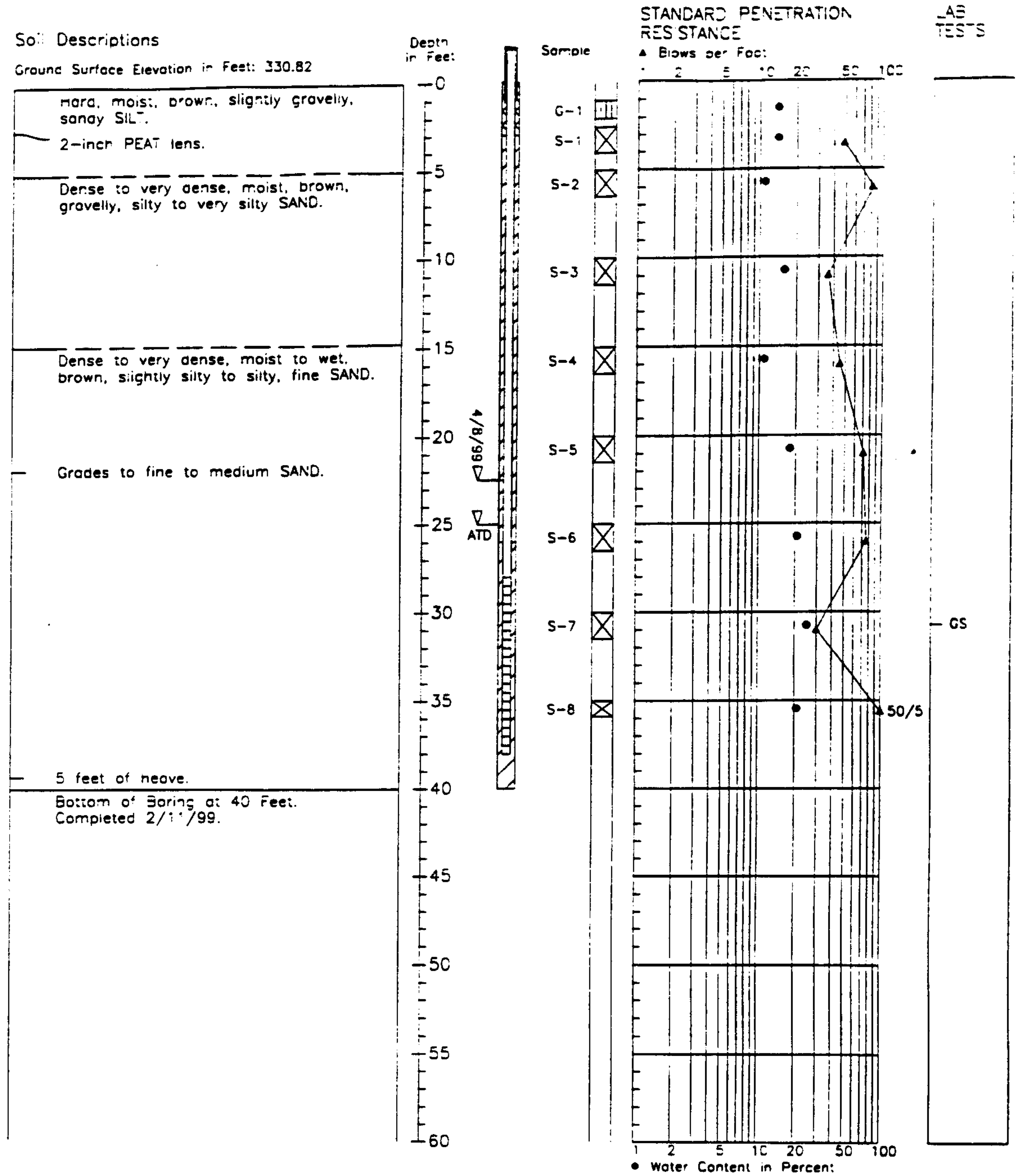
J-4978-06 2/99

Figure A-15

Boring Log HC99-B46

N 11,530.74, E 20,896.43



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2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

CVD 7/27/99 1=1 WDSTK-B1C7
497R\DGS\99 BORINGS

HARTCROWSER

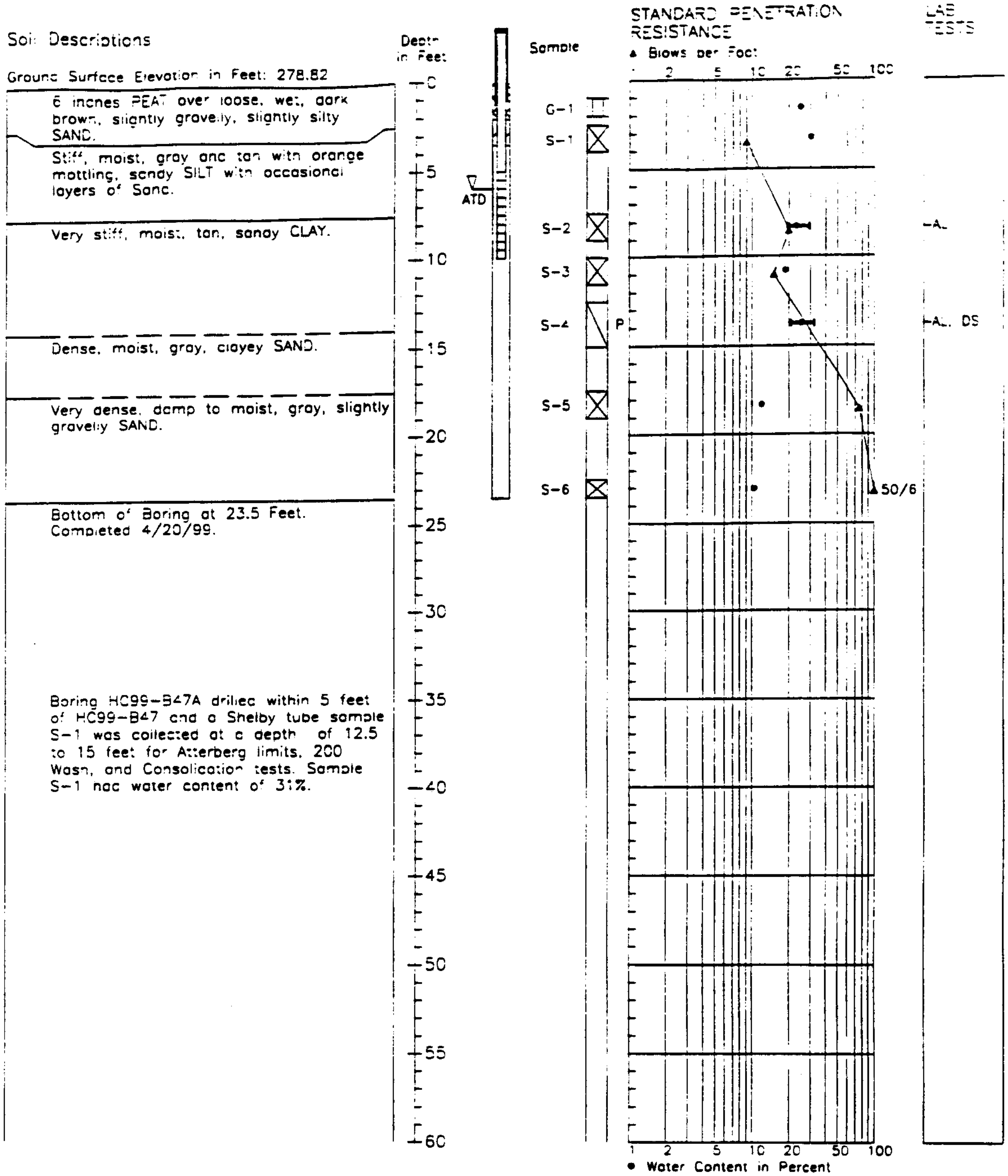
J-4978-06 2/99

Figure A-16

AR 042570

Boring Log HC99-B47

N 11,432.63, E 21,955.31



1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

CVD 7/21/99 1=1 WDS1K-B PC2
4978\LOGS\99 BORINGS

HARTCROWSER

J-4978-06 5/99

Figure A-17

Test Pit Log HC99-TP1

N 11,795.46, E 18,749.38

Sample	Water Content	Lab Tests
S-1	32	
S-2	19	GS
S-3	16	GS
S-4	13	
S-5	18	

Depth in Feet: 0–20

SOIL DESCRIPTIONS
Ground Surface Elevation in Feet: 342

(Loose), moist, brown, silty, very gravelly SAND. (FILL) over (loose to medium dense), moist, gray, very silty, fine SAND to very sandy SILT.

(Medium stiff), moist, gray, slightly sandy SILT.

Bottom of Test Pit at 8½ Feet.
Completed 2/16/99.

Test Pit Log HC99-TP2

N 11,670.21, E 18,707.60

Sample	Water Content
S-1	10
S-2	24
S-3	17
S-4	19
S-5	14

Depth in Feet: 0–20

SOIL DESCRIPTIONS
Ground Surface Elevation in Feet: 324

(Loose to medium dense), wet, gray, silty, very gravelly SAND. (FILL)

(Soft to medium stiff), moist, brown, sandy SILT.

(Medium dense), moist to wet, gray, silty, gravelly SAND.

(Medium stiff to stiff), moist, gray mottled brown, sandy SILT with occasional thin layers of Clay.

Grades to (stiff), moist, tan, sandy SILT.

Severe caving.

Bottom of Test Pit at 15 Feet.
Completed 2/16/99.

Groundwater seepage observed at a depth of ½, 5, and 10½ feet.

CVD 7/27/99DSIK-8 PC2
4978\LOGS\TP01-02

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater conditions, if indicated, are at the time of excavation. Conditions may vary with time.

HARTCROWSER
J-4978-06 2/99
Figure A-18

AR 042572

Test Pit Log HC99-TP3

N 11,698.04, E 48,819.88

Ground Surface Elevation in Feet: 33'

Sample	Water Content	Lab Tests	Depth in Feet	Soil Descriptions
S-1	22		0–4	(Loose to dense), moist, brown, silty, gravelly SAND to sandy SILT. (FILL)
S-2	13			
S-3	28		4–8	(Soft), moist, brown, slightly sandy SILT
			8–11	(Stiff to hard), moist, gray mottled with brown, slightly sandy, silty CLAY.
S-4	32	AL		
S-5	19		11–17	(Dense to very dense), moist to wet, gray, silty, fine SAND
S-7	28		17	Grades to fine to medium SAND.

Bottom of Test Pit at 17½ Feet.
Completed 2/16/99.

Groundwater seepage at 15 feet; groundwater table encountered at a depth of 17½ feet.

Test Pit Log HC99-TP4

N 11,642.99, E 19,100.40

Ground Surface Elevation in Feet: 339

Sample	Water Content	Depth in Feet	Soil Descriptions
S-1	19	0–1	(Soft), moist, brown, sandy SILT.
S-2	7	1–5	(Loose to medium dense), moist, brown, silty, very gravelly SAND with scattered concrete and asphalt blocks. (FILL)
		4	2-foot-diameter concrete pipe.
S-3	14	5–7	(Medium dense), moist, gray, slightly gravelly, silty SAND to sandy SILT.
S-4	15	7–9	Grades to (medium dense), gravelly, very silty SAND to very sandy SILT.
		9	Becomes saturated.

Bottom of Test Pit at 9 Feet.
Completed 2/16/99.

Groundwater seepage encountered at a depth of 7½ Feet.

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater conditions, if indicated, are at the time of excavation. Conditions may vary with time.

CVD 1=1 WDSIK 8PC2
4978\LOGS\TP03 04

HARTCROWSER
J-4978-06 2/99
Figure A-19

Test Pit Log HC99-TP5

N 11,663.86, E 19,178.74

Sample	Water Content
S-1	23
S-2	14
S-3	15
S-4	15
S-5	9

Depth in Feet: 0–20

SOIL DESCRIPTIONS
Ground Surface Elevation in Feet: 344

Depth in Feet	Soil Description
0–1	(Soft), moist, brown, sandy SILT.
1–4	(Medium dense), moist, brown, silty, very gravelly SAND.
4–8	(Dense), moist, gray, gravelly, silty SAND to sandy SILT.
8–12.5	(Very stiff), moist, gray, slightly gravelly, sandy SILT.
12.5–13	(Hard), moist, gray, gravelly, sandy SILT. (TILL)

Bottom of Test Pit at 13 Feet.
Completed 2/16/99.

Groundwater seepage observed at a depth of 12-1/2 feet.

Test Pit Log HC99-TP6

N 11,656.03, E 19,284.06

Sample	Water Content
S-1	8
S-2	12
S-3	22
S-4	12

Depth in Feet: 0–20

SOIL DESCRIPTIONS
Ground Surface Elevation in Feet: 348

Depth in Feet	Soil Description
0–1	(Loose), moist, dark gray, slightly silty SAND. (FILL)
1–7	(Soft), moist, brown, slightly gravelly, sandy SILT.
7–11	(Dense), moist, gray, gravelly, very silty SAND to very sandy SILT.

Bottom of Test Pit at 11 Feet.
Completed 2/16/99.

CVD 1=1 WDSIK 8PC?
4978\LOGS\TP05-06

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater conditions, if indicated, are at the time of excavation. Conditions may vary with time.

HARTCROWSER
J-4978-06 2/99
Figure A-20

Test Pit Log HC99-TP7

N 11,541.76, E 19,056.32

Sample	Water Content
S-1	40
S-2	30
S-3	17
S-4	11
S-5	11

SOIL DESCRIPTIONS
Ground Surface Elevation in Feet: 322

Depth in Feet	Description
0	(Soft), moist, dark brown, sandy SILT.
1	(Soft), moist, brown, slightly gravelly, sandy SILT.
4	(Loose to medium dense), wet, gray, gravelly, very silty SAND. Running ground due to groundwater flow from 5 to 7 feet.
7	(Medium stiff to stiff), moist, gray, slightly gravelly, sandy SILT.
12	Grades to (hard), moist, gray, slightly gravelly, sandy SILT.
13.5	Bottom of Test Pit at 13.5 Feet. Completed 2/16/99.

Groundwater seepage observed at depths of 5 and 6 Feet.

Test Pit Log HC99-TP8

N 11,860.43, E 19,179.52

Sample	Water Content
S-1	34
S-2	14
S-3	21
S-4	18
S-5	15
S-6	14

SOIL DESCRIPTIONS
Ground Surface Elevation in Feet: 364

Depth in Feet	Description
0	(Soft), moist, dark brown, sandy SILT. (TOPSOIL)
1	(Soft to medium stiff), moist, gray, sandy SILT.
2	(Medium stiff), moist, brown, slightly gravelly, sandy SILT.
4	(Medium dense), moist, gray, very silty SAND to very sandy SILT. Red stains observed.
10	(Dense), moist, gray, very silty SAND. Moderate caving from 10 to 14 feet depths.
14	(Hard), moist, gray, slightly sandy, gravelly SILT.
15	Bottom of Test Pit at 15 Feet. Completed 2/16/99.

Groundwater seepage observed at a depth of 5 and 14 Feet.

CVD 1-1 WDSTK-8 PC2
4978\OKS\TP07-08

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater conditions, if indicated, are at the time of excavation. Conditions may vary with time.

HARTCROWSER
J-4978-06 2/99
Figure A-21

Test Pit Log HC99-TP9

N 11,517.076, E 19,190.28

Sample	Water Content	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet: 326
S-1	31		0–1.5	(Soft), moist, dark brown, slightly sandy SILT.
S-2	17		1.5–2.5	(Loose to medium dense), moist, brown, silty, very gravelly SAND
S-3	12		2.5–9	(Medium dense to dense), moist, gray, slightly gravelly, very silty SAND.
S-4	15	GS	9–12.5	(Dense), moist to wet, gray, gravelly, slightly silty SAND to very sandy SILT.
S-5	16	AL	12.5–13	(Hard), moist, gray, slightly gravelly, sandy CLAY

Bottom of Test Pit at 13 Feet.
Completed 2/16/99.
Groundwater seepage observed at a depth of 6 Feet.

Test Pit Log HC99-TP10

N 11,058.59, E 21,671.89

Sample	Water Content	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet: 278
S-1	14		0–1.5	(Loose), damp, dark brown, slightly gravelly, fine to medium SAND. (TOPSOIL)
S-2	11		1.5–2.5	(Loose), damp, tan, slightly gravelly, fine to medium SAND.
S-3	18	GS	2.5–5	(Medium dense), moist, gray, very gravelly SAND.
S-4	24		5–7.5	(Very stiff), moist, gray with orange mottling, slightly gravelly SILT.
S-5	12		7.5–14.5	(Very stiff), moist, dark gray, slightly gravelly, slightly sandy, silty SAND.

Bottom of Test Pit at 14-1/2 Feet.
Completed 4/12/99.

No groundwater seepage observed.

CVD 1=1 WDSTK-8PC2
4978\LOGS\TP09-10

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater conditions, if indicated, are at the time of excavation. Conditions may vary with time.

HARTCROWSER
J-4978-06 2/99
Figure A-22

Test Pit Log HC99-TP11

N 11,181.36, E 21,592.84

Sample	Water Content	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet: 284
S-1	26	0–1	(Loose), moist, dark brown to black, very silty SAND.
S-2	20	1–2	(Medium dense), moist, tan, gravelly, very silty, fine SAND.
S-3	21	2–8	(Medium dense), moist to wet, brown, slightly silty, slightly gravelly SAND. Seepage approximately 1 gpm. 2 inches of (stiff) clayey SILT.
S-4	13	8–15-1/2	(Dense to very dense), wet, blue-gray, silty, sandy GRAVEL
		15-1/2	Bottom of Test Pit at 15-1/2 Feet. Completed 4/12/99. Groundwater seepage observed at a depth of 3-3/4 feet.

Test Pit Log HC99-TP12

N 10,918.78, E 21,477.90

Sample	Water Content	Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet: 282
S-1	3	0–3	(Medium dense), moist, orange to brown, slightly gravelly, silty SAND.
S-2	24	3–8	(Stiff), moist, gray with orange mottling, slightly gravelly, slightly sandy SILT.
S-3	13	8–14	(Very dense), moist, gray, slightly gravelly, silty to very silty SAND.
		14	Bottom of Test Pit at 14 Feet. Completed 4/12/99. Groundwater seepage observed at a depth of 3 feet.

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater conditions, if indicated, are at the time of excavation. Conditions may vary with time.

CVD 1-1 WDSIK-8PC2
4978\LOGS\TP01-07

HARTCROWSER
J-4978-06 4/99
Figure A-23

Test Pit Log HC99-TP13

N 11,064.60, E 21,287.50

Ground Surface Elevation in Feet: 290

Sample	Water Content	Depth in Feet	SOIL DESCRIPTIONS
S-1	13	0–1	(Loose), damp to moist, dark brown, silty SAND with occasional debris (brick fragments and plastic) (FILL)
		1–4	(Loose), moist to wet, brown, silty, medium SAND.
		4	Seepage approximately 1 gpm.
S-2	22	4–7	(Loose to medium dense), wet, gray, slightly silty, very gravelly, medium to coarse SAND.
S-3	23	7–15	(Stiff to hard), wet, blue-gray, slightly sandy, slightly gravelly SILT.
		15	Bottom of Test Pit at 15 Feet. Completed 4/12/99. Groundwater seepage observed at a depth of 4½ feet.

Test Pit Log HC99-TP14

N 11,018.33, E 20,847.31

Ground Surface Elevation in Feet: 308

Sample	Water Content	Depth in Feet	SOIL DESCRIPTIONS
S-1	24	0–1	(Loose), damp, dark brown, slightly gravelly, silty SAND.
S-2	19	1–6	(Loose to medium dense), moist, brown, silty fine SAND.
		4	6-inch layer of (stiff), damp, tan with orange mottling, slightly gravelly SILT.
S-3	10	6–8	(Medium dense), moist to wet, gray, very sandy GRAVEL.
		7½	Very slight seepage.
S-4	20	8–11	(Stiff to hard), moist, tan with orange mottling, slightly sandy, gravelly, clayey SILT.
S-5	12	11–17	(Dense), moist to wet, slightly silty, gravelly SAND.
		17	Bottom of Test Pit at 17 Feet. Completed 4/12/99. Groundwater seepage observed at a depth of 7½ feet.

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater conditions, if indicated, are at the time of excavation. Conditions may vary with time.

CVD 1=1 WDSTK-8PC2
49/R\OGS\TP13-14

HARTCROWSER

J-4978-06 4/99

Figure A-24

Test Pit Log HC99-TP15

N 10,705.64, E 21,200.49

Ground Surface Elevation in Feet: 276

Sample	Water Content	Depth in Feet	Soil Descriptions
S-1	12	0–3.5	(Medium dense), damp to moist, brown, gravelly, silty SAND with organic material and debris (brick fragments and concrete pieces). (FILL)
S-2	7	3.5–9	(Dense), moist, tan, slightly gravelly, medium SAND.
		8	6-inch layer of (hard), damp, tan and gray, gravelly SILT
S-3	22	9–16	(Stiff), moist to wet, gray, slightly sandy SILT.

Bottom of Test Pit at 16 Feet.
Completed 4/8/99.

Groundwater seepage observed at depths of 8 and 9 feet.
Slight petroleum-like odor noted at a depth of 8 feet.

Test Pit Log HC99-TP16

N 10,778.91, E 20,889.3

Ground Surface Elevation in Feet: 290

Sample	Water Content	Depth in Feet	Soil Descriptions
S-1	19	0–2.5	(Medium dense), damp to moist, brown, gravelly, silty SAND with abundant debris (brick fragments and concrete pieces). (FILL)
S-2	23	2.5–9	(Loose), moist to wet, brown and orange, slightly gravelly, slightly silty, coarse SAND.
		5	Large 3-foot-diameter boulder encountered.
S-3	15	9–16.5	(Stiff to hard), moist to wet, gray, sandy, gravelly SILT.
		15	Increasing silt content.

Bottom of Test Pit at 16-1/2 feet.
Completed 4/12/99.

Groundwater seepage observed at depths of 8-1/2 and 9 feet.

CVD 1=1 WDSTK-8PC2
4978\LOGS\TP15 16

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater conditions, if indicated, are at the time of excavation. Conditions may vary with time.

HARTCROWSER
J-4978-06 4/99
Figure A-25

Test Pit Log HC99-TP17

N 10,818.27, E 20,624.32

Sample	Water Content
S-1	15
S-2	17
S-3	28
S-4	23
S-5	19

SOIL DESCRIPTIONS
Ground Surface Elevation in Feet: 296

Depth in Feet	Description
0–3	(Medium dense), damp, dark brown, slightly gravelly, silty SAND with debris (brick fragments, concrete pieces, and wood). (FILL)
3–6	(Medium dense), moist, brown SAND.
6–8.5	(Stiff), moist to wet, brown with orange mottling, sandy SILT.
8.5–12.5	(Loose), moist, gray SAND.
~12	8 inches of (Loose), wet, brown, very sandy GRAVEL.
12.5–15	(Stiff to hard), wet, gray, sandy SILT.

Bottom of Test Pit at 15 Feet.
Completed 4/12/99.

Groundwater seepage observed at a depth of 11-3/4 feet.

Test Pit Log HC99-TP18

N 10,628.87, E 20,757.75

Sample	Lab Tests
S-1	
S-2	
S-3	
S-4	GS
S-5	AL
S-6	

SOIL DESCRIPTIONS
Ground Surface Elevation in Feet: 284

Depth in Feet	Description
0–2	(Loose), damp, gray and brown, slightly silty, very gravelly SAND with debris (brick fragments and charcoal). (FILL)
2–4	(Medium dense), damp, orange to brown, slightly gravelly, silty SAND with organic material.
4–8.5	(Loose), wet, gray, slightly silty, very gravelly, medium to coarse SAND.
8.5–10	(Stiff), moist to wet, gray with orange mottling, slightly sandy, clayey SILT.
10–16.5	(Medium stiff to hard), wet, gray, slightly sandy, clayey SILT.

Bottom of Test Pit at 16-1/2 Feet.
Completed 4/12/99.

Groundwater seepage observed at depths of 4 and 7 feet.

CVD 1=1 WDSIK-8PC2
4978\DCS\TP17-18

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater conditions, if indicated, are at the time of excavation. Conditions may vary with time.

HARTCROWSER

J-4978-06 4/99

Figure A-26

Test Pit Log HC99-TP19

N 10,611.83, E 20,585.59

Ground Surface Elevation in Feet: 286

Sample	Water Content	Depth in Feet	Soil Descriptions
S-1	15	0–1	(Loose), damp, dark brown, slightly silty SAND.
S-2	14	1–5	(Medium dense), damp, brown to orange, slightly silty, medium SAND.
S-3	21	4½	Slight to moderate seepage.
S-4	28	5–8	(Dense), moist, gray, slightly silty, fine to medium SAND.
		7½	Slight seepage.
S-5	18	8–16	(Stiff), wet, blue-gray, sandy SILT.
		16	Bottom of Test Pit at 16 Feet. Completed 4/7/99. Groundwater seepage observed at depths of 4½ and 7½ feet.

Test Pit Log HC99-TP20

N 10,513.61, E 20,945.70

Ground Surface Elevation in Feet: 278

Sample	Water Content	Depth in Feet	Soil Descriptions
S-1	20	0–1½	(Loose), damp to moist, dark brown, silty SAND with debris (charcoal). (FILL)
S-2	12	1½–4½	(Dense), moist, light brown, slightly gravelly, slightly silty, fine SAND.
S-3	15	4½–8	(Loose to medium dense), wet, gray, very gravelly, coarse SAND with occasional cobbles.
S-4	29	8–9	(Stiff), moist to wet, tan, sandy SILT.
S-5	18	9–15	(Medium stiff to hard), wet, gray, sandy SILT.
		15	Bottom of Test Pit at 15 Feet. Completed 4/12/99. Groundwater seepage observed at a depth of 7 feet.

CVD 1=1 WDSIK-8PC2
4978\LOGS\TP19-20

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater conditions, if indicated, are at the time of excavation. Conditions may vary with time.

HARTCROWSER

J-4978-06 4/99

Figure A-27

Test Pit Log HC99-TP21

N 10,416.98, E 20,627.60

Sample	Water Content
S-1	9
S-2	16
S-3	10
S-4	27
S-5	32
S-6	21

Depth in Feet: 0–20

SOIL DESCRIPTIONS
Ground Surface Elevation in Feet: 278

(Loose), damp, dark brown, slightly silty SAND (TOPSOIL)

(Medium dense), moist, gray, gravelly SAND

(Loose), damp, brown, slightly silty, slightly gravelly SAND with organic material.

(Medium dense), damp to moist, light brown, slightly silty, fine to medium SAND.

(Stiff), moist, gray with orange mottling, sandy SILT

(Loose), wet, brown, medium to coarse SAND.

(Stiff to hard), wet, gray, slightly gravelly, slightly sandy SILT.

Increasing gravel content.

Bottom of Test Pit at 9 Feet.
Completed 4/12/99.

Groundwater seepage observed at a depth of 7½ feet.

CVD 1-1 WDS1K-8 PC2
4978\LOGS\TP01-02

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater conditions, if indicated, are at the time of excavation. Conditions may vary with time.

HARTCROWSER
J-4978-06 2/99
Figure A-28

AR 042582

Test Pit Log HC98-TP1

N 11,340, E 17,180

Sample	Water Content
S-1	8
S-2	12
S-3	12
S-4	10
S-5	9
S-6	7

Depth in Feet — SOIL DESCRIPTIONS
Ground Surface Elevation in Feet: 346

Depth in Feet	Soil Descriptions
0–1.5	(Loose), dry to moist, silty, gravelly, fine SAND with scattered roots. (FILL)
1.5–3	(Stiff), dry to moist, gray, sandy, gravelly SILT with scattered roots.
3–5.5	(Medium stiff), moist, gray-brown, slightly gravelly, sandy SILT.
5.5–13	(Medium dense to dense), moist, gray-brown, gravelly, silty, fine SAND.
11	Iron staining.
13–15	(Dense to very dense), moist, gray-brown, slightly silty, fine SAND.
15	Bottom of Test Pit at 15 Feet. Completed 7/30/98.
	Slight caving from depth of 10 to 14 feet.

Test Pit Log HC98-TP2

N 11,400, E 18,950

Sample	Water Content	Lab Tests
S-1	7	
S-2	11	
S-3	30	AL
S-4	13	
S-5	11	
S-6	21	

Depth in Feet — SOIL DESCRIPTIONS
Ground Surface Elevation in Feet: 361

Depth in Feet	Soil Descriptions
0–1.5	(Loose), dry to moist, gray-brown, gravelly, very silty, fine SAND with scattered roots. (FILL)
1.5–3.5	(Stiff), moist, light brown, gravelly, sandy SILT with occasional cobbles and roots.
3.5–7.5	(Stiff to very stiff), moist, brown-gray SILT.
7.5–14	(Dense), moist, gray-brown with occasional iron staining, silty, gravelly, fine to medium SAND.
14–15	(Very dense), wet, gray-brown, slightly gravelly, very silty, fine SAND.
15	Bottom of Test Pit at 15 Feet. Completed 7/30/98.

CVD 5/3/99 1=1 WNSIK RPC2
4978\LOGS\98 TEST PITS

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater conditions, if indicated, are at the time of excavation. Conditions may vary with time.

HARTCROWSER
J-4978-06 7/98
Figure A-29

Test Pit Log HC98-TP3

N 11,410, E 17,560

Ground Surface Elevation in Feet: 299

Sample	Water Content
S-1	8
S-2	10
S-3	21
S-4	16
S-5	14
S-6	3
S-7	27

Depth in Feet	Soil Descriptions
0–3	(Loose to medium dense), moist, gray, slightly gravelly, silty, fine to medium SAND. (FILL)
3–4.5	(Very stiff), moist, gray-brown mottled, fine sandy SILT.
4.5–7	(Dense), moist, gray, silty, fine SAND.
7–9.5	(Very dense), moist, gray, silty, gravelly, fine SAND to gravelly SAND.
9.5–15	(Stiff), moist, gray, clayey SILT with slickensides and fractures.

Bottom of Test Pit at 15 Feet.
Completed 7/30/98.

Test Pit Log HC98-TP4

N 11,380, E 17,780

Ground Surface Elevation in Feet: 274

Sample	Water Content	Lab Tests
S-1	9	
S-2	10	
S-3	9	
S-4	16	GS
S-5	17	

Depth in Feet	Soil Descriptions
0–4	(Medium dense), moist, brown-gray, silty, gravelly SAND. (FILL)
4–11	(Dense), moist, gray-brown mottled, slightly gravelly, silty, fine to medium SAND to gravelly, fine to medium SAND.
11–14.5	(Dense), wet, gray, silty, fine to medium SAND.
14.5–15	(Dense), wet, mottled gray and red-brown, slightly silty, gravelly SAND.

Bottom of Test Pit at 15 Feet.
Completed 7/30/98.

Groundwater seepage observed at a depth of 12 and 14½ feet.
Slight caving observed from depth of 14 to 15 feet.

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater conditions, if indicated, are at the time of excavation. Conditions may vary with time.

CVD 5/3/99 1=1 WDSTK-8PC2
4978\OGS\98 TEST PITS

HARTCROWSER

J-4978-06 7/98

Figure A-30

Test Pit Log HC98-TP5

N 11,430, E 17,930

Sample	Water Content
S-1	19
S-2	14
S-3	27
S-4	10

Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet: 283
0	(Loose), moist, brown, silty, fine to medium SAND with abundant roots. (FILL?)
1	(Medium stiff), moist, mottled gray and brown, fine sandy SILT
8	Becomes clayey.
11	(Dense), moist, gray, slightly gravelly to gravelly, silty, fine to medium SAND.
15	Bottom of Test Pit at 15 Feet. Completed 7/30/98.

Test Pit Log HC98-TP6

N 11,500, E 18,330

Sample	Water Content	Lab Tests
S-1	7	
S-2	4	
S-3	22	
S-4	9	
S-5	10	
S-6	15	GS

Depth in Feet	SOIL DESCRIPTIONS Ground Surface Elevation in Feet: 300
0	(Loose), moist, brown, slightly silty, gravelly SAND with abundant roots. (FILL)
1.5	(Medium dense), moist, gray to brown, silty, gravelly SAND.
4.5	(Medium dense), moist, gray to brown, silty, fine SAND.
9	(Dense), wet, gray to brown, gravelly SAND.
13	Becomes silty.
15	Slight seepage.
17	(Dense to very dense), wet, gray and brown, slightly gravelly, silty SAND.
18	Slight to moderate seepage.
20	Bottom of Test Pit at 20 Feet. Completed 7/30/98.

Groundwater seepage observed at a depths of 12, 14, and 18 feet.

Moderate caving below 7 feet.

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater conditions, if indicated, are at the time of excavation. Conditions may vary with time.

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Figure A-31

CVD 5/3/99 1=1 WDSIK 8PC2
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Test Pit Log HC98-TP7

N 11,520, E 18,550

Sample	Water Content	Lab Tests
S-1	6	
S-2	4	
S-3	3	
S-4	14	
S-5	11	
S-6	9	
S-7	14	
S-8	25	GS

Depth in Feet: 0–20

SOIL DESCRIPTIONS
Ground Surface Elevation in Feet: 308

- (Loose), moist, brown, silty, gravelly SAND with occasional roots (FILL)
- (Loose to medium dense), moist, brown, slightly silty, gravelly SAND. (FILL)
- (Stiff), moist, gray with brown, fine sandy SILT.
- (Dense), moist, mottled gray and brown, silty, gravelly SAND.
- (Dense), wet, gray, slightly silty, medium SAND.
- (Dense), wet, gray, gravelly SAND with occasional silty zones
- (Dense), wet, gray-brown, fine to medium SAND.

Substantial seepage.

Bottom of Test Pit at 18 Feet.
Completed 7/30/98.

Groundwater seepage observed at depths of 14 and 16 feet.
Moderate caving below 10 feet.

Test Pit Log HC98-TP8

N 11,339.54, E 18,305.82

Sample	Water Content	Lab Tests
S-1	3	
S-2	4	
S-3	19	
S-4	10	
S-5	15	GS

Depth in Feet: 0–20

SOIL DESCRIPTIONS
Ground Surface Elevation in Feet: 278

- (Loose), moist, gray and brown, slightly silty, slightly gravelly, fine to medium SAND with scattered roots. (FILL)
- (Dense), moist, gray and brown, gravelly, fine to medium SAND.
- (Stiff), moist, gray and brown, slightly gravelly, sandy SILT.
- (Dense), moist, red-brown to gray-brown, silty, gravelly SAND.
- (Dense), wet, gray, slightly gravelly, silty SAND.

Bottom of Test Pit at 14 Feet.
Completed 7/30/98.

Groundwater seepage observed at a depth of 13 feet.

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater conditions, if indicated, are at the time of excavation. Conditions may vary with time.

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Figure A-32

CVD 5/3/99 1=1 WDSIK-8PC2
4978\LOGS\98 TEST PITS

Test Pit Log HC98-TP9

N 11,320, E 18,450

Sample	Water Content	Lab Tests
S-1	8	
S-2	7	
S-3	8	
S-4	27	
S-5	34	
S-6	15	
S-7	36	AL
S-8	15	

SOIL DESCRIPTIONS
Ground Surface Elevation in Feet: 286

Depth in Feet	Soil Description
0 – 3	(Loose to medium dense), moist to dry, light brown, gravelly, silty fine SAND with scattered roots. (FILL)
3 – 6	(Medium dense), moist, light gray-brown, fine SAND.
6 – 10	(Stiff), moist, light gray, slightly sandy SILT. Iron staining.
10 – 11.5	(Stiff), moist, mottled light gray, slightly sandy SILT with fractures.
11.5 – 15	(Medium dense), wet, gray-brown, slightly silty, gravelly, fine to medium SAND.
15 – 17.5	(Stiff), moist to wet, gray, silty CLAY.
17.5 – 18	(Very dense), wet, gray, slightly silty, gravelly, fine to medium SAND.

Bottom of Test Pit at 18 Feet.
Completed 7/30/98.

Groundwater seepage observed at a depth of 16 feet.
Moderate caving from depth of 10 to 14 feet.

Test Pit Log HC98-TP10

N 11,390, E 18,950

Sample	Water Content	Lab Tests
S-1	19	
S-2	8	
S-3	30	
S-4	11	GS
S-5	16	
S-6	11	

SOIL DESCRIPTIONS
Ground Surface Elevation in Feet: 306

Depth in Feet	Soil Description
0 – 1	(Stiff), moist, mottled gray and red-brown, fine sandy SILT.
1 – 2	(Loose), moist, brown, silty, gravelly SAND.
2 – 5	(Dense), moist, mottled gray and red-brown, fine to medium SAND. Pipe encountered. 6-inch layer of sandy SILT.
5 – 12.5	(Dense), wet, gray, slightly gravelly to gravelly, silty to very silty, fine to medium SAND.
12.5 – 14	(Dense), wet, gray, slightly silty, gravelly, fine to medium SAND.

Bottom of Test Pit at 14 Feet.
Completed 7/30/98.

Groundwater seepage observed at a depth of 7 feet.
Severe caving below 5 feet.

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater conditions, if indicated, are at the time of excavation. Conditions may vary with time.

CVD 5/3/99 1=1 WDSIK-8PC2
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Figure A-33

Test Pit Log HC98-TP11

N 11,390, E 18,130

Ground Surface Elevation in Feet: 287

Sample	Water Content	Depth in Feet	Soil Descriptions
S-1	14	0–1	(Soft), moist, light brown, sandy SILT with scattered roots
S-2	15	1.5–3.5	(Medium stiff), moist, light brown, slightly sandy SILT with scattered organic material.
S-3	17	3.5–6.5	(Medium dense), moist, gray-brown, silty SAND, scattered organic material.
S-4	8	6.5–9	(Dense), moist, gray, slightly silty, gravelly, fine to medium SAND.
S-5	11	9.5–15.5	(Very dense), wet, gray-brown, silty, gravelly, fine to medium SAND.
S-6	13		
S-7	13		

Bottom of Test Pit at 15-1/2 feet.
Completed 7/30/98.

Groundwater seepage observed at a depth of 15 feet.
Moderate caving below 10 feet.

Test Pit Log HC98-TP12

N 11,330, E 17,930

Ground Surface Elevation in Feet: 260

Sample	Water Content	Lab Tests	Soil Descriptions
S-1	17		(Loose), moist, brown, silty, fine to medium SAND. (FILL)
S-2	7		(Dense), moist, gray, slightly silty, gravelly, fine to medium SAND. (FILL)
			Pipe encountered. Flow approximately 2 gpm.
S-3	18		(Hard), moist, gray, sandy, gravelly SILT.
S-4	35	AL	(Stiff), wet, gray and brown, clayey SILT.
S-5	18		(Dense), wet, gray, slightly silty, gravelly, fine to medium SAND.

Bottom of Test Pit at 15 Feet.
Completed 7/30/98.

Groundwater seepage observed at a depth of 7-1/2 feet.
Severe caving at 7-1/2 feet.

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater conditions, if indicated, are at the time of excavation. Conditions may vary with time.

CVD 5/3/99 1=1 WDSIK BPC2
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Figure A-34

APPENDIX B
LABORATORY TESTING PROGRAM

APPENDIX B
LABORATORY TESTING PROGRAM

A laboratory testing program was performed for this study to evaluate the basic index and geotechnical engineering properties of the site soils. Both disturbed and relatively undisturbed samples were tested. The tests performed and the procedures followed are outlined below.

Soil Classification

Field Observation and Laboratory Analysis. Soil samples from the explorations were visually classified in the field and then taken to our laboratory where the classifications were verified in a relatively controlled laboratory environment. Field and laboratory observations include density/consistency, moisture condition, and grain size and plasticity estimates.

The classifications of selected samples were checked by laboratory tests such as Atterberg limits determinations and grain size analyses. Classifications were made in general accordance with the Unified Soil Classification (USC) System, ASTM D 2487, as presented on Figure B-1.

Note that the term "with" used on boring logs generally indicates a material within the soil matrix that constitutes a relatively small fraction by weight of the total soil. The usage of this term in not associated with the ASTM simplified classification procedure.

Water Content Determinations

Water contents were determined for most samples recovered in the explorations in general accordance with ASTM D 2216, as soon as possible following their arrival in our laboratory. Water contents were not determined for very small samples nor samples where large gravel contents would result in values considered unrepresentative. The results of these tests are plotted or recorded at the respective sample depth on the exploration logs. In addition, water contents are routinely determined for samples subjected to other testing. These are also presented on the exploration logs.

Grain Size Analysis (GS)

Grain size distribution was analyzed on representative samples in general accordance with ASTM D 422. Wet sieve analysis was used to determine the size distribution greater than the U.S. No. 200 mesh sieve. The size distribution for particles smaller than the No. 200 mesh sieve was determined by the hydrometer method for a selected number of samples. The results of the tests are presented as curves on Figures B-2 through B-12 plotting percent finer by weight versus grain size.

200-Wash

One sample was subjected to a modified grain size classification known as a 200-wash. The samples were "washed" through the No. 200 mesh sieve to determine the relative percentages of coarse- and fine-grained material in the samples. The tests were performed in general accordance with ASTM D 1140. This was performed for Shelby tube sample HC99-B47A at a depth interval between 12.5 and 15 feet. The results indicated 28 percent passing the No. 200 sieve; therefore, the soil is a silty fine sand at the location the sample for analysis was taken. We expect that this is a sandier zone in the overall Shelby sampled interval, as the majority of the sample was sandy silt.

Atterberg Limits (AL)

We determined Atterberg limits for selected fine-grained soil samples. The liquid limit and plastic limit were determined in general accordance with ASTM D 4318-84. The results of the Atterberg limits analyses and the plasticity characteristics are summarized in the Liquid and Plastic Limits Test Report, Figures B-13 through B-18. This relates the plasticity index (liquid limit minus the plastic limit) to the liquid limit. The results of the Atterberg limits tests are shown graphically on the boring logs as well as where applicable on figures presenting various other test results.

Atterberg limits provides a classification of the fine-grained fraction of a soil (i.e., passing the U.S. No. 200 sieve). This is based on the behavior of the soil in response to accepted mechanical tests, but does not accurately distinguish between clay and silt-size particles. Our visual classifications were, in our opinion, more representative of the soil than the Atterberg classification. This was the case for samples visually classified as sandy silt or silt, by Hart Crowser that were classified as "CL" by the Atterberg chart. The low plasticity indices of these samples further support our use of the classification of silt rather than clay.

Consolidation Test (CN)

The one-dimensional consolidation test provides data for estimating settlement and preconsolidation pressure. The test was performed in general accordance with ASTM D 2435. A relatively undisturbed, fine-grained sample was carefully trimmed and fit into a rigid ring with porous stones placed on the top and bottom of the sample to allow drainage. Vertical loads were then applied incrementally to the sample in such a way that the sample was allowed to consolidate under each load increment. Measurements were made of the compression of the sample (with time) under each load increment. Rebound was measured during the unloading phase. In general, each load was left in place until the completion of 100 percent primary consolidation, as computed using Taylor's square root of time method. The next load increment was applied soon after attaining 100 percent primary consolidation. For the 4 tsf load increment, the load was left in-place for about 16 hours to record secondary compression characteristics. The test results plotted in terms of axial strain and coefficient of consolidation versus applied load (stress) are presented on Figure B-19.

Direct Shear Test (DS)

The undrained direct shear test was performed by PSI, Inc., in general accordance with ASTM D 3080-90. The test sample was trimmed from a relatively undisturbed soil sample and placed in the direct shear box. The sample was not allowed to consolidate under an applied vertical load prior to shearing. A horizontal force was applied to the shear box containing the sample. In this way, the sample fails along a predetermined failure plane. The shearing took place at a constant strain rate, and was done quickly enough so that no drainage would occur.

The data are presented on a Mohr-Coulomb diagram plotting shear (failure) stress versus normal stress. The line through the points of failure represents the effective angle of internal friction (Ø) and the intercept along the vertical axis the apparent cohesion (c'). The test results are shown in Figure B-20.

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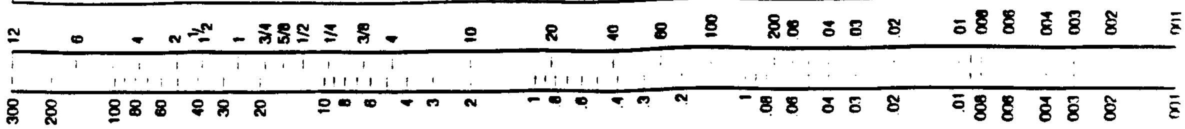
Unified Soil Classification (USC) System

Soil Grain Size

Size of Opening in Inches	Number of Mesh per Inch (US Standard)	Grain Size in Millimetres



Grain Size in Millimetres

COBBLES	GRAVEL	SAND	SILT and CLAY
Coarse-Grained Soils			Fine-Grained Soils

Coarse-Grained Soils

G W	G P	G M	G C	S W	S P	S M	S C
Clean GRAVEL <5% fines		GRAVEL with >12% fines		Clean SAND <5% fines		SAND with >12% fines	
GRAVEL >50% coarse fraction larger than No. 4				SAND >50% coarse fraction smaller than No. 4			
Coarse-Grained Soils >50% larger than No. 200 sieve							

G W and S W $\left(\frac{D_{60}}{D_{10}}\right)$ >4 for G W, >6 for S W & $1 \leq \left(\frac{(D_{30})^2}{D_{10} \times D_{60}}\right) \leq 3$

G P and S P Clean GRAVEL or SAND not meeting requirements for G W and S W

G M and S M Atterberg limits below A line with PI <4

G C and S C Atterberg limits above A Line with PI >7

* Coarse-grained soils with percentage of fines between 5 and 12 are considered borderline cases required use of dual symbols.

D_{10}, D_{30}, and D_{60} are the particles diameter of which 10, 30, and 60 percent, respectively, of the soil weight are finer.

Fine-Grained Soils

M L	C L	O L	M H	C H	O H	Pt
SILT	CLAY	Organic	SILT	CLAY	Organic	Highly Organic Soils
Soils with Liquid Limit <50%			Soils with Liquid Limit >50%			
Fine-Grained Soils >50% smaller than No. 200 sieve						

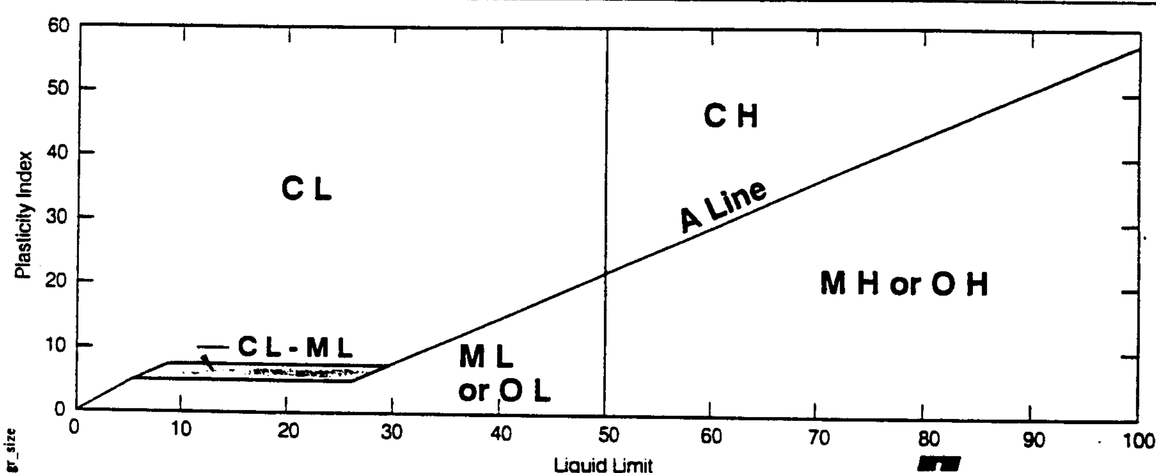


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Figure B-1

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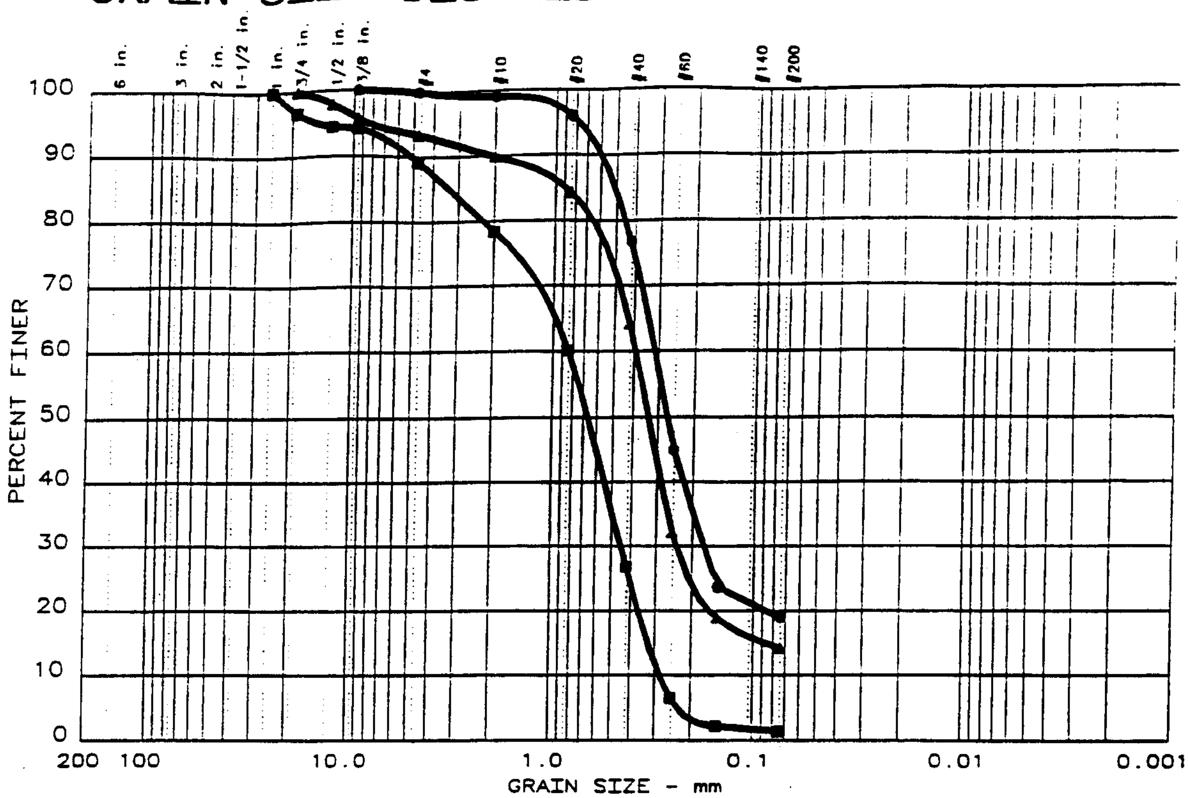
GRAIN SIZE DISTRIBUTION TEST REPORT



	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	0.1	81.0	18.9	
▲	0.0	6.6	79.2	14.2	
■	0.0	10.8	87.8	1.4	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.51	0.31	0.27	0.174				
▲			0.88	0.39	0.33	0.238	0.0884			
■			3.31	0.84	0.66	0.448	0.3243	0.2825	0.85	3.0

MATERIAL DESCRIPTION	USCS	NAT. MOIST.
● Silty SAND	SM	25%
▲ Slightly gravelly, silty SAND	SM	17%
■ Slightly gravelly SAND	SP	17%

Remarks:

Project: Third Runway
● Location: HC99-B32, S-3
▲ Location: HC99-B32, S-4
■ Location: HC99-B33, S-4

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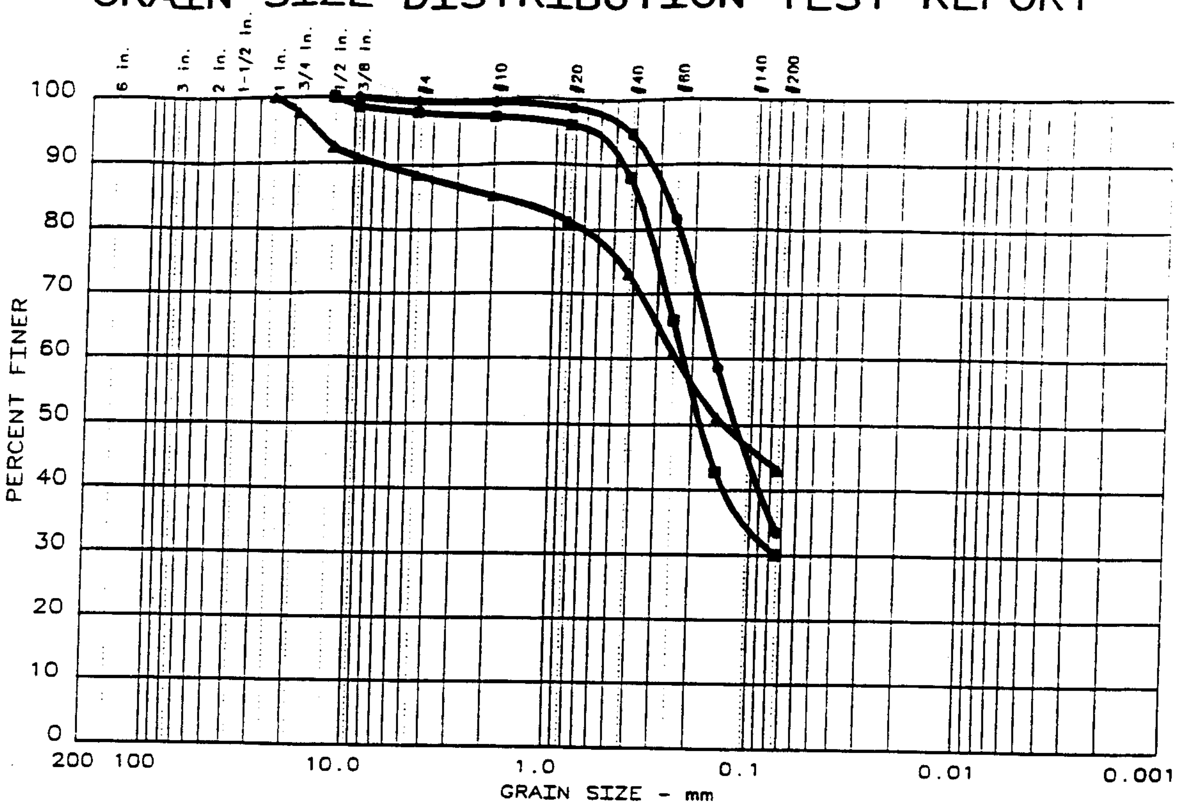
Figure B-2

GRAIN SIZE DISTRIBUTION TEST REPORT



	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	0.2	66.4	33.4	
▲	0.0	11.5	45.5	43.0	
■	0.0	1.9	68.1	30.0	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.28	0.15	0.12					
▲			2.02	0.24	0.14					
■			0.38	0.22	0.18					

MATERIAL DESCRIPTION	USCS	NAT. MOIST.
● Very silty SAND	SM	30%
▲ Very silty SAND	SM	13%
■ Very silty SAND	SM	14%

Remarks:

Project: Third Runwa[illegible]

● Location: HC99-B34, S-2

▲ Location: HC99-B35, S-4

■ Location: HC99-B36, G-1

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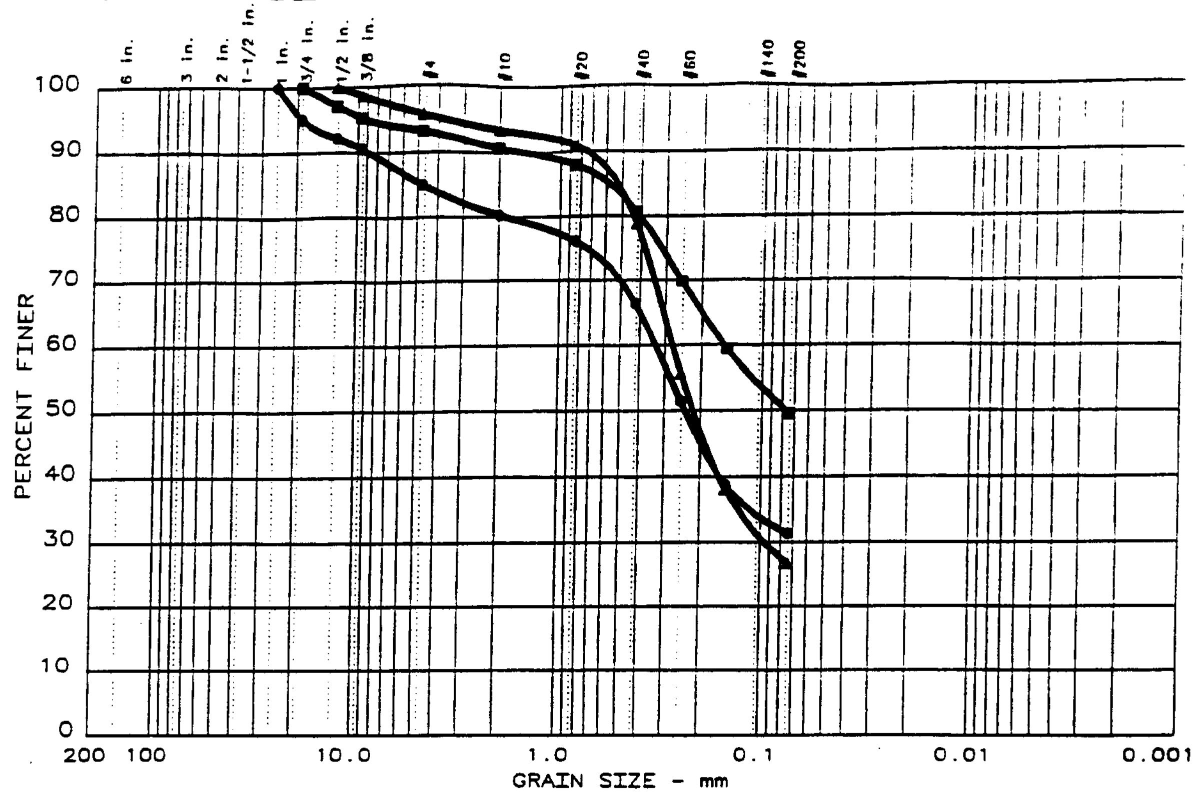
Figure B-3

GRAIN SIZE DISTRIBUTION TEST REPORT



	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	15.0	53.7	31.3	
▲	0.0	4.3	69.0	26.7	
■	0.0	6.8	43.7	49.5	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			4.73	0.33	0.24					
▲			0.52	0.28	0.22	0.095				
■			0.58	0.15	0.08					

MATERIAL DESCRIPTION	USCS	NAT. MOIST.
● Gravelly, very silty SAND	SM	
▲ Silty SAND	SM	19%
■ Slightly gravelly, very sandy SILT	ML	27%

Remarks:

Project: 3rd Runway
● Location: HC99-B36, S-2
▲ Location: HC99-B37, S-2
■ Location: HC99-B37, S-4

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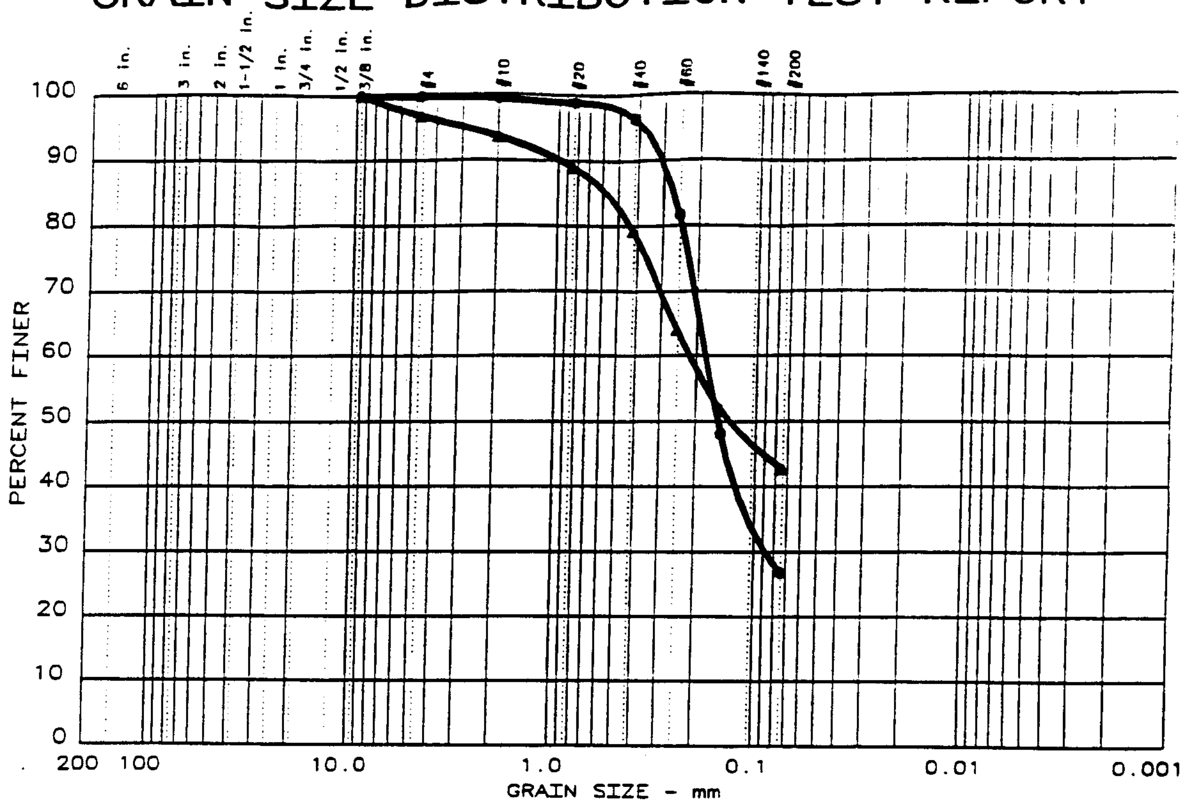
Figure B-4

GRAIN SIZE DISTRIBUTION TEST REPORT



	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	0.3	72.8	26.9	
▲	0.0	3.3	54.2	42.5	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.27	0.18	0.15	0.087				
▲			0.57	0.22	0.13					

MATERIAL DESCRIPTION	USCS	NAT. MOIST.
● Silty SAND	SM	25%
▲ Very silty SAND	SM	11%

Remarks:

Project: 3rd Runway
● Location: HC99-B39, S-2
▲ Location: HC99-B40, S-4

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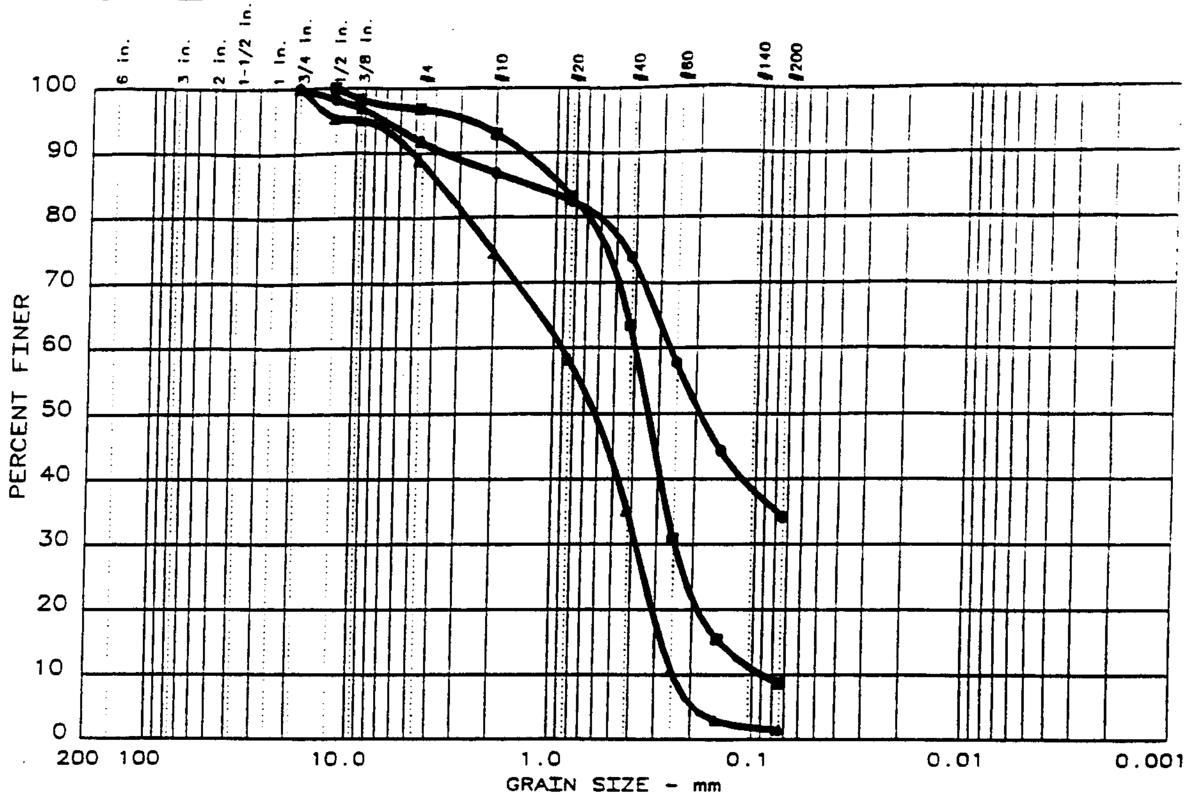
Figure B-5

GRAIN SIZE DISTRIBUTION TEST REPORT



	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	8.2	57.7	34.1	
▲	0.0	11.0	87.5	1.5	
■	0.0	3.2	88.0	8.8	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			1.33	0.27	0.19					
▲			3.67	0.90	0.62	0.378	0.2786	0.2443	0.65	3.7
■			0.94	0.39	0.34	0.245	0.1442	0.0889	1.71	4.4

MATERIAL DESCRIPTION	USCS	NAT. MOIST.
● Slightly gravelly, silty SAND	SM	12%
▲ Slightly gravelly SAND	SP	17%
■ Slightly silty SAND	SP-SM	20%

Remarks:

Project: 3rd Runway
● Location: HC99-B38, S-4
▲ Location: HC99-B31, S-4
■ Location: HC99-B31, S-5

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Figure B-6

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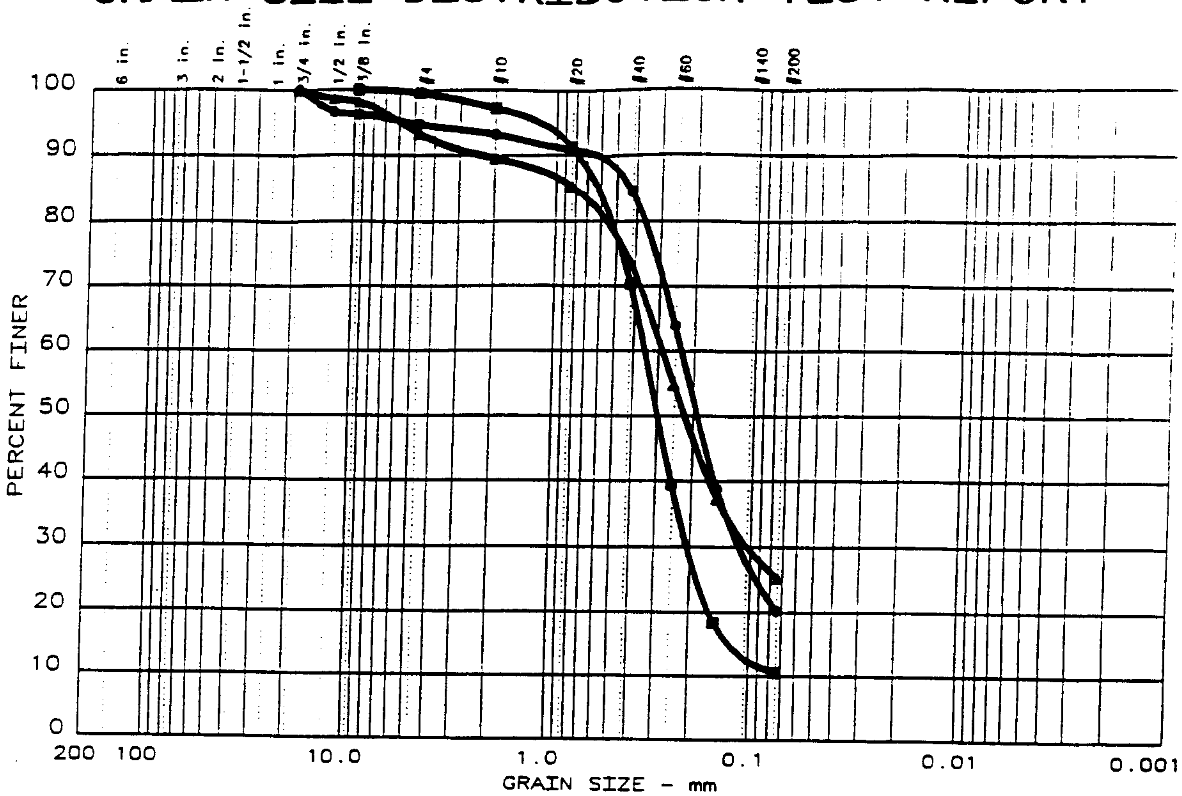
GRAIN SIZE DISTRIBUTION TEST REPORT



	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	5.3	74.5	20.2	
▲	0.0	6.8	68.0	25.2	
■	0.0	0.5	88.9	10.6	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.43	0.23	0.19	0.114				
▲			0.80	0.29	0.22	0.104				
■			0.62	0.35	0.30	0.207	0.1263			

MATERIAL DESCRIPTION	USCS	NAT. MOIST.
● Slightly gravelly, silty SAND	SM	20%
▲ Slightly gravelly, silty SAND	SM	16%
■ Slightly silty SAND	SP-SM	22%

Remarks:

Project: Third Runway
- ● Location: HC99-B40, S-2
- ▲ Location: HC99-B40, S-3
- ■ Location: HC99-B41, S-7

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Figure B-7

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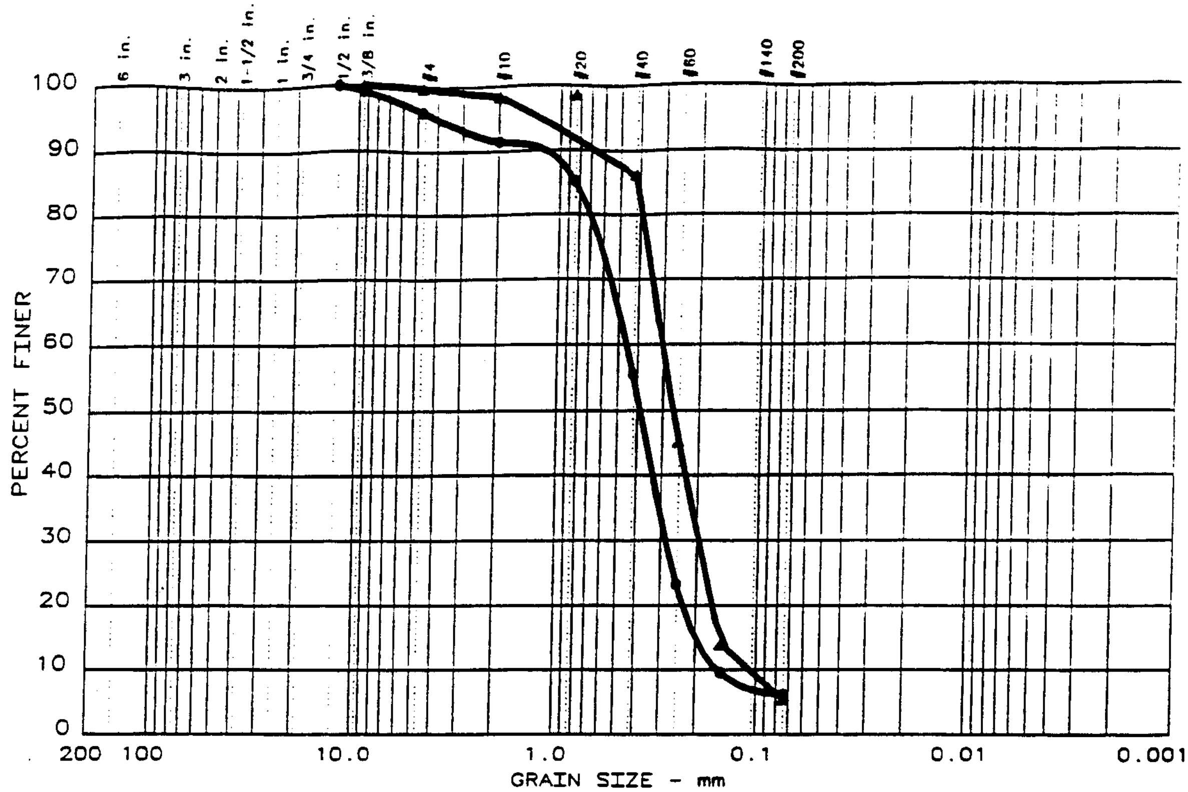
GRAIN SIZE DISTRIBUTION TEST REPORT



	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	3.9	89.9	6.2	
▲	0.0	0.2	94.3	5.5	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.83	0.45	0.39	0.283	0.1995	0.1531	1.15	3.0
▲			0.41	0.30	0.27	0.194	0.1515	0.1073	1.16	2.8

MATERIAL DESCRIPTION	USCS	NAT. MOIST.
● Slightly silty SAND	SP-SM	20%
▲ Slightly silty SAND	SP-SM	25%

Remarks:

Project: Third Runway
● Location: HC99-B43, S-2
▲ Location: HC99-B46, S-7

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Figure B-8

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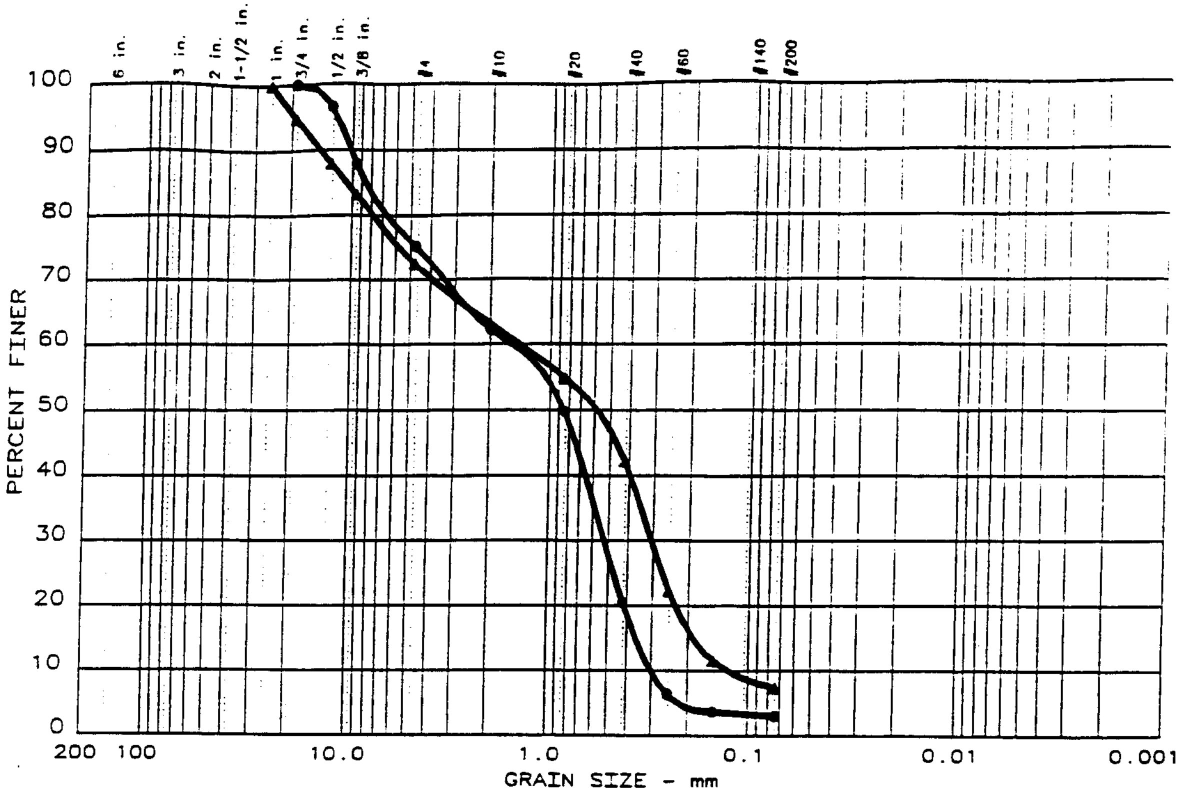
GRAIN SIZE DISTRIBUTION TEST REPORT



	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	24.7	72.3	3.0	
▲	0.0	27.5	65.1	7.4	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			8.51	1.55	0.85	0.523	0.3610	0.3027	0.58	5.1
▲			10.47	1.41	0.58	0.305	0.1862	0.1245	0.53	11.4

MATERIAL DESCRIPTION	USCS	NAT. MOIST.
● Gravelly SAND	SP	18%
▲ Slightly silty, gravelly SAND	SP-SM	15%

Remarks:

Project: 3R 99 Fill
● Location: HC99 -TP1, S-3
▲ Location: HC99 -TP9, S-4

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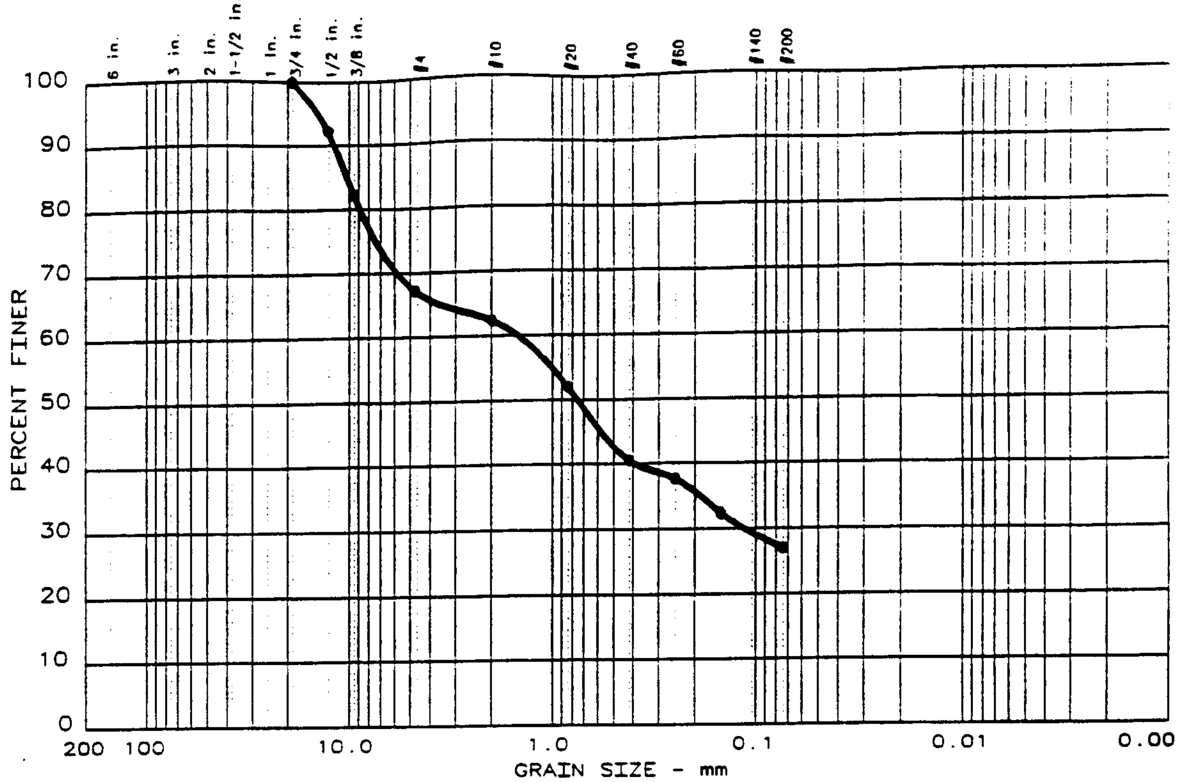
Figure B-9

GRAIN SIZE DISTRIBUTION TEST REPORT



	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	32.7	40.3	27.0	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			10.23	1.48	0.75	0.114				

MATERIAL DESCRIPTION	USCS	NAT. MOIST.
● Silty, very gravelly SAND	SM	19%

Remarks:

Project: 3rd Runway

● Location: HC99-TP1, S-2

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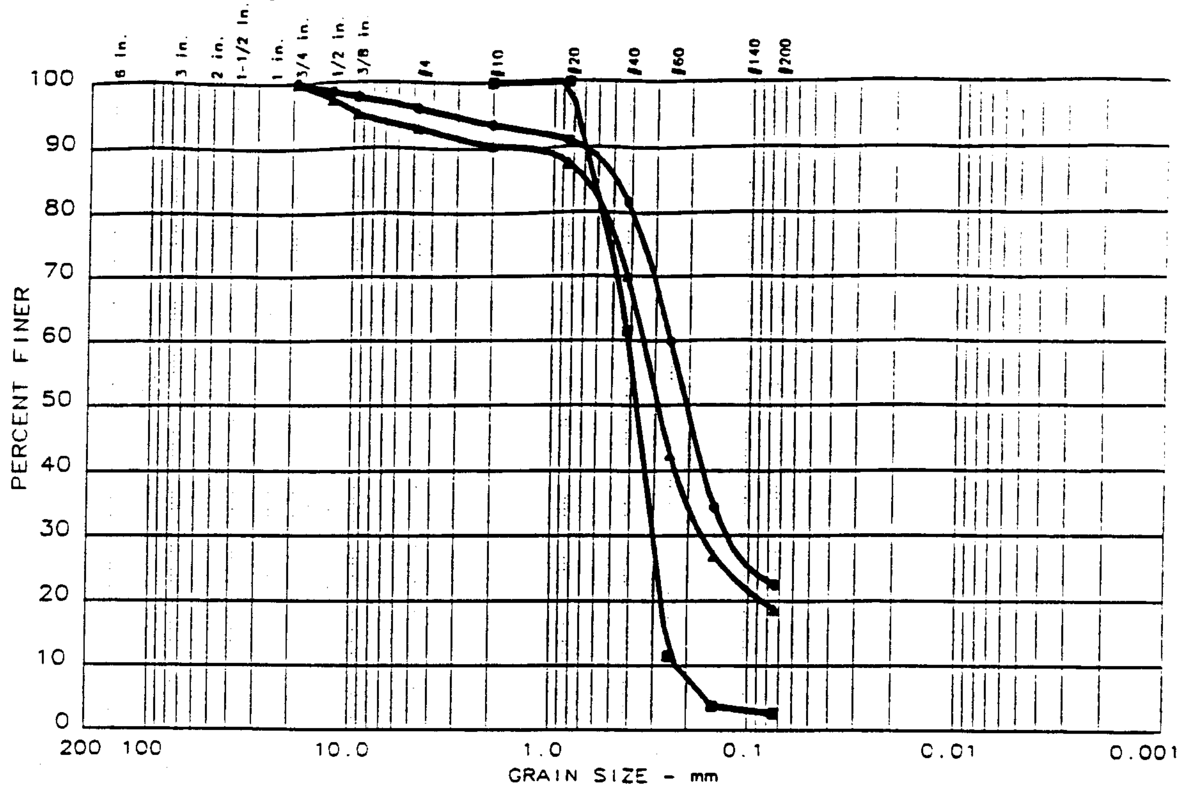
J-4978-06 3/9/99

Figure B-10

AR 042602

GRAIN SIZE DISTRIBUTION TEST REPORT



	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	3.8	73.7	22.5	
▲	0.0	6.9	74.4	18.7	
■	0.0	0.0	97.4	2.6	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.48	0.25	0.21	0.129				
▲			0.68	0.35	0.29	0.172				
■			0.63	0.41	0.37	0.303	0.2591	0.2257	0.98	1.8

MATERIAL DESCRIPTION	USCS	NAT. MOIST.
● Silty SAND	SM	16%
▲ Slightly gravelly, silty SAND	SM	15%
■ SAND	SP	25%

Remarks:

Project: 3rd Runway Phase II

● Location: HC98-TP4, S-4

▲ Location: HC98-TP6, S-6

■ Location: HC98-TP7, S-8

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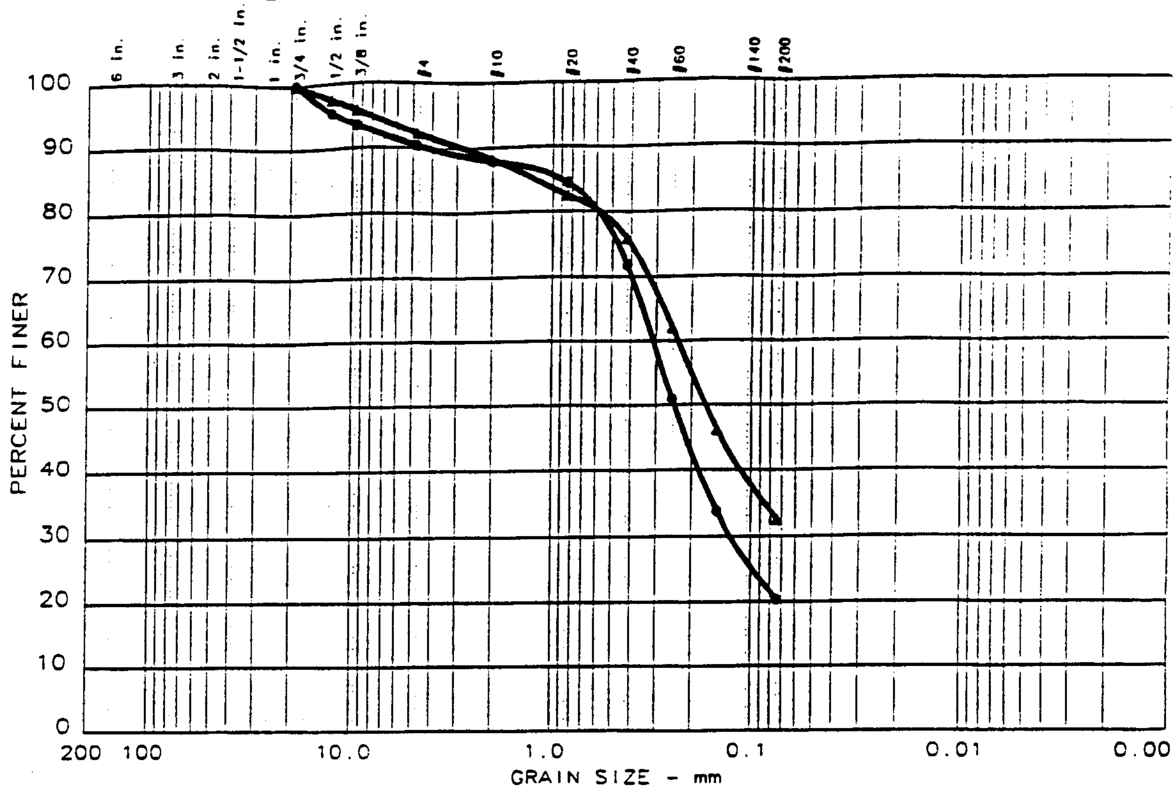
J-4978-06 8/4/98

Figure B-11

GRAIN SIZE DISTRIBUTION TEST REPORT



	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	9.5	70.2	20.3	
▲	0.0	7.7	59.8	32.5	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.89	0.31	0.24	0.126				
▲			1.22	0.23	0.17					

MATERIAL DESCRIPTION	USCS	NAT. MOIST.
● Slightly gravelly, silty SAND	SM	15%
▲ Slightly gravelly, very silty SAND	SM	11%

Remarks:

Project: 3rd Runway Phase II
● Location: HC98-TP8, S-5
▲ Location: HC98-TP10, S-4

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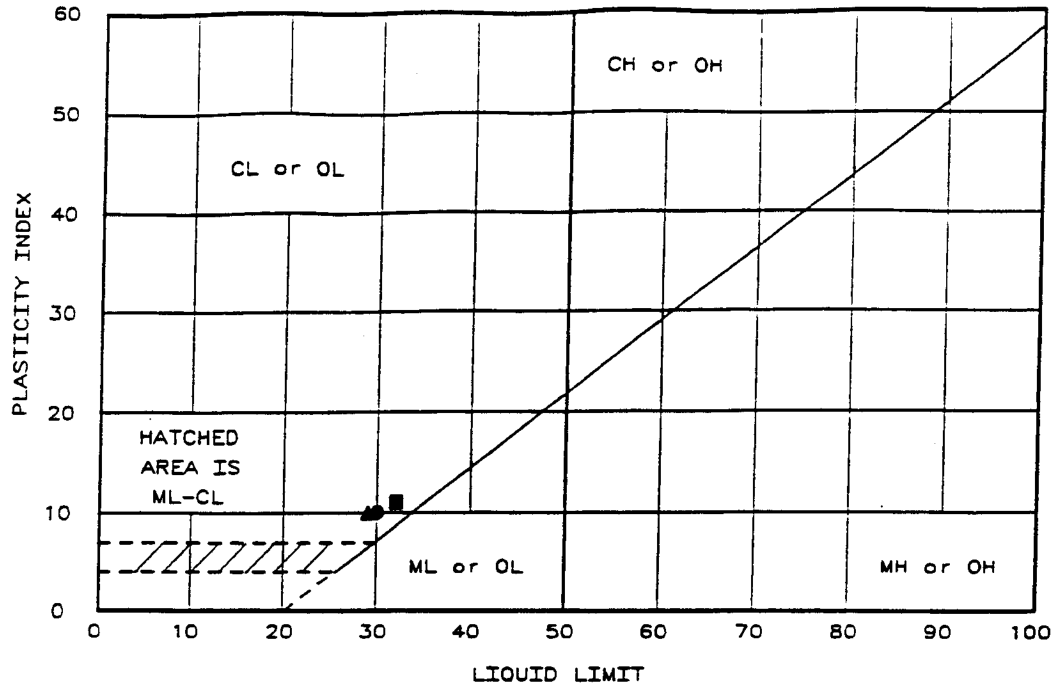
J-4978-06 8/4/98
Figure B-12

AR 042604

LIQUID AND PLASTIC LIMITS TEST REPORT



	Location + Description	LL	PL	PI	-200	ASTM D 2487-90
●	HC99-B47A, S-1 Depth 12.5 to 15 feet	30	20	10		Clayey, fine SAND
▲	HC99-B47, S-2 Depth 7.5 to 9 feet	29	19	10		Sandy CLAY
■	HC99-B47, S-4 Depth 12.5 to 15 feet	32	21	11		Sandy CLAY

Remarks:

HC99-B47A, S-1, confirmed clayey, fine SAND using 200 wash mechanical sieve procedure

Project: 3rd Runway

Client:

Location: SeaTac Airport, Washington

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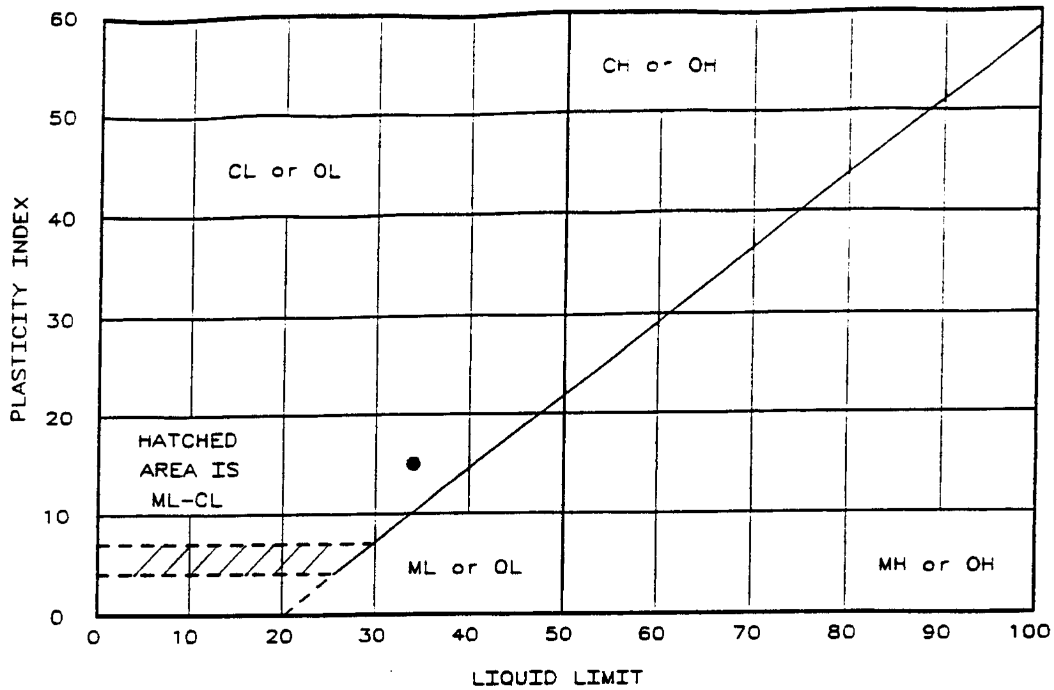
Figure B-13

LIQUID AND PLASTIC LIMITS TEST REPORT



Location + Description	LL	PL	PI	-200	ASTM D 2487-90
● HC99 -TP9, S-5	34	19	15		CLAY

Remarks:

Project: 3R 99 Fill

Client:

Location: SeaTac Airport, Washington

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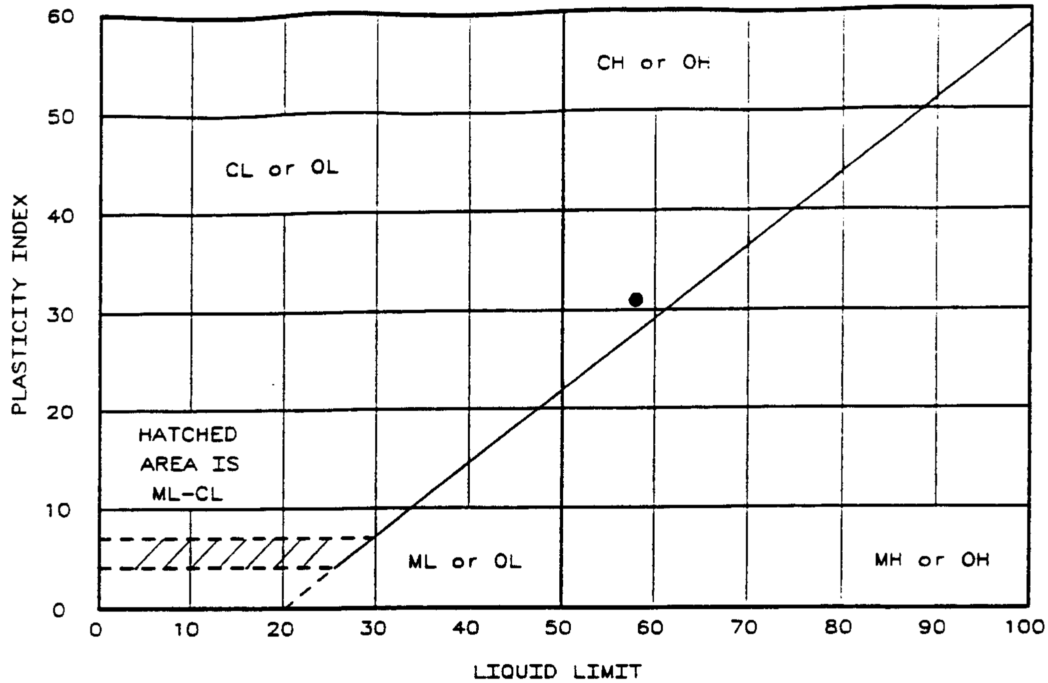
J-4978-05 4/24/99

Figure B-14

AR 042606

LIQUID AND PLASTIC LIMITS TEST REPORT



	Location + Description	LL	PL	PI	-200	ASTM D 2487-90
●	HC-99/TP-3, S-4 Depth 10.5 to 11 feet	58	27	31		Slightly sandy, silty CLAY

Remarks:

Project: 3rd Runway

Client:

Location: SeaTac, Airport, Washington

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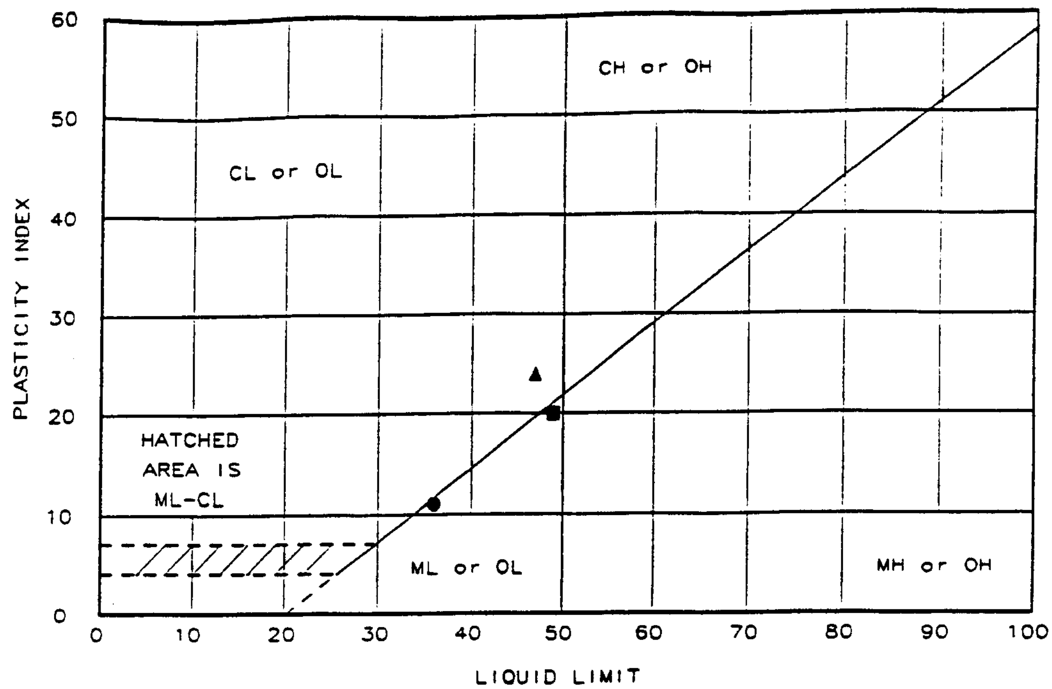
J-4978-06 3/9/99

Figure B-15

AR 042607

LIQUID AND PLASTIC LIMITS TEST REPORT



Location + Description	LL	PL	PI	-200	ASTM D 2487-90
● HC98-TP2, S-3, Depth 3.5 to 4.5 feet	36	25	11		SILT
▲ HC98-TP9, S-7, Depth 15 to 16 feet	47	23	24		Silty CLAY
■ HC98-TP12, S-4, Depth 4 to 4.5 feet	49	29	20		Clayey SILT

Remarks:

Project: 3rd Runway

Client:

Location: Seattle, Washington

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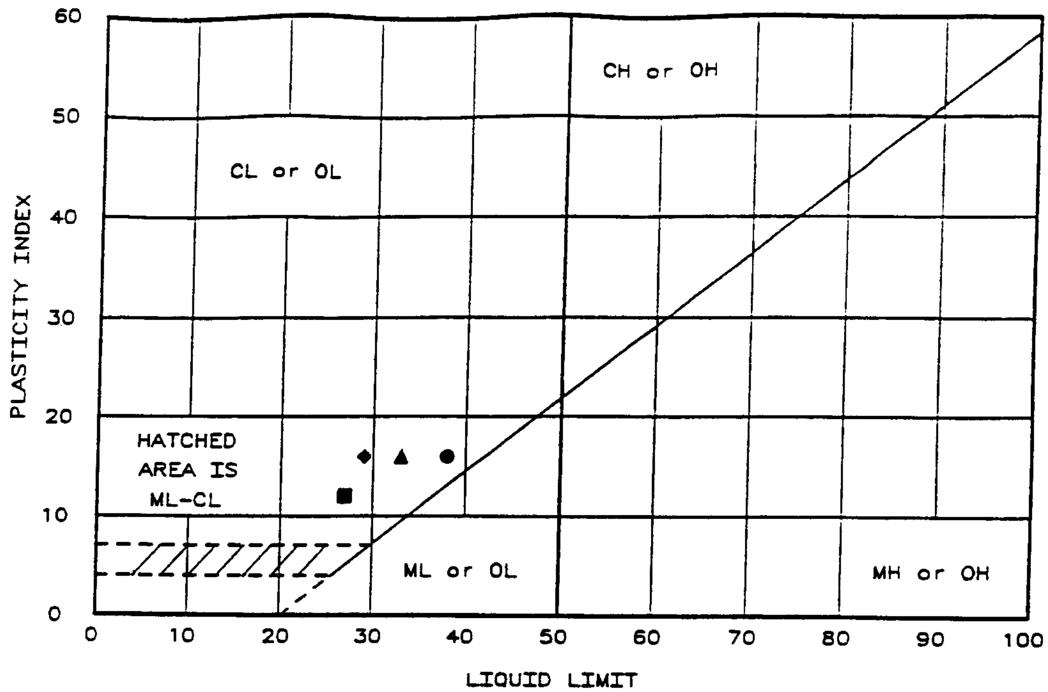
Figure B-16

LIQUID AND PLASTIC LIMITS TEST REPORT



Location + Description	LL	PL	PI	-200	ASTM D 2487-90
● HC99-B45, S-2	38	22	16		Slightly sandy CLAY
▲ HC99-B45, S-3	33	17	16		Slightly sandy CLAY
■ HC99-B45, S-4	27	15	12		Slightly sandy CLAY
◆ HC99-B37, S-3	29	13	16		Sandy, clayey PEAT

Remarks:

Project: 3rd Runway

Client:

Location: SeatTac Airpot, Washington

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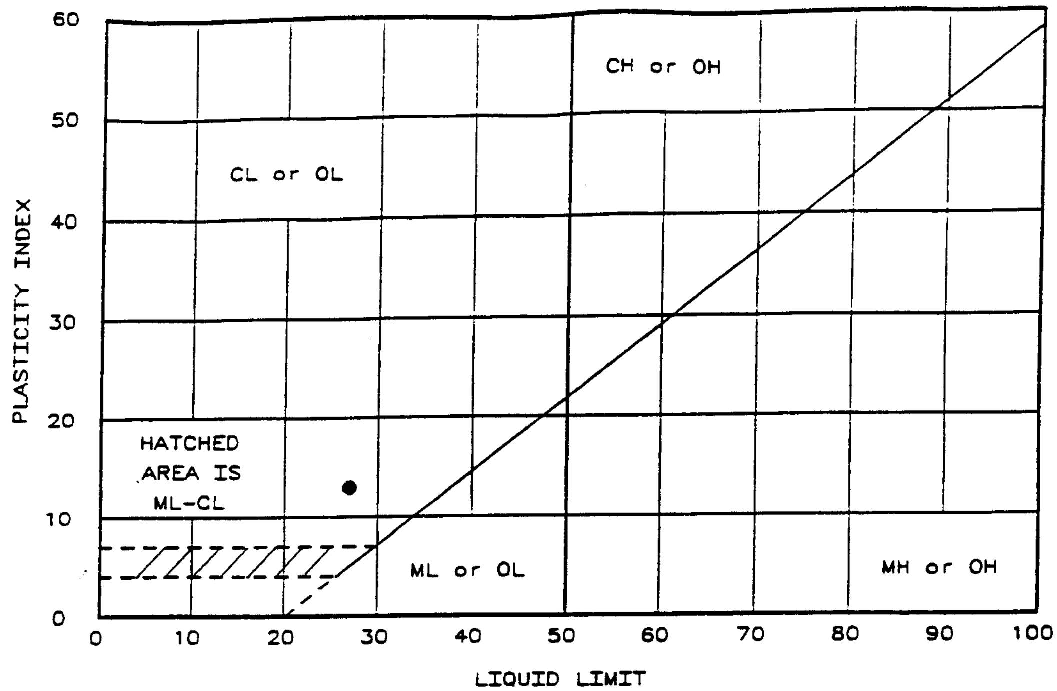
J-4978-06 5/6/99
Figure B-17

LIQUID AND PLASTIC LIMITS TEST REPORT



Location + Description	LL	PL	PI	-200	ASTM D 2487-90
● HC99-B35, S-2, Depth 8 to 9.5 feet	27	14	13		Slightly sandy CLAY

Remarks:

Project: Third Runway

Client:

Location: SeaTac, Washington

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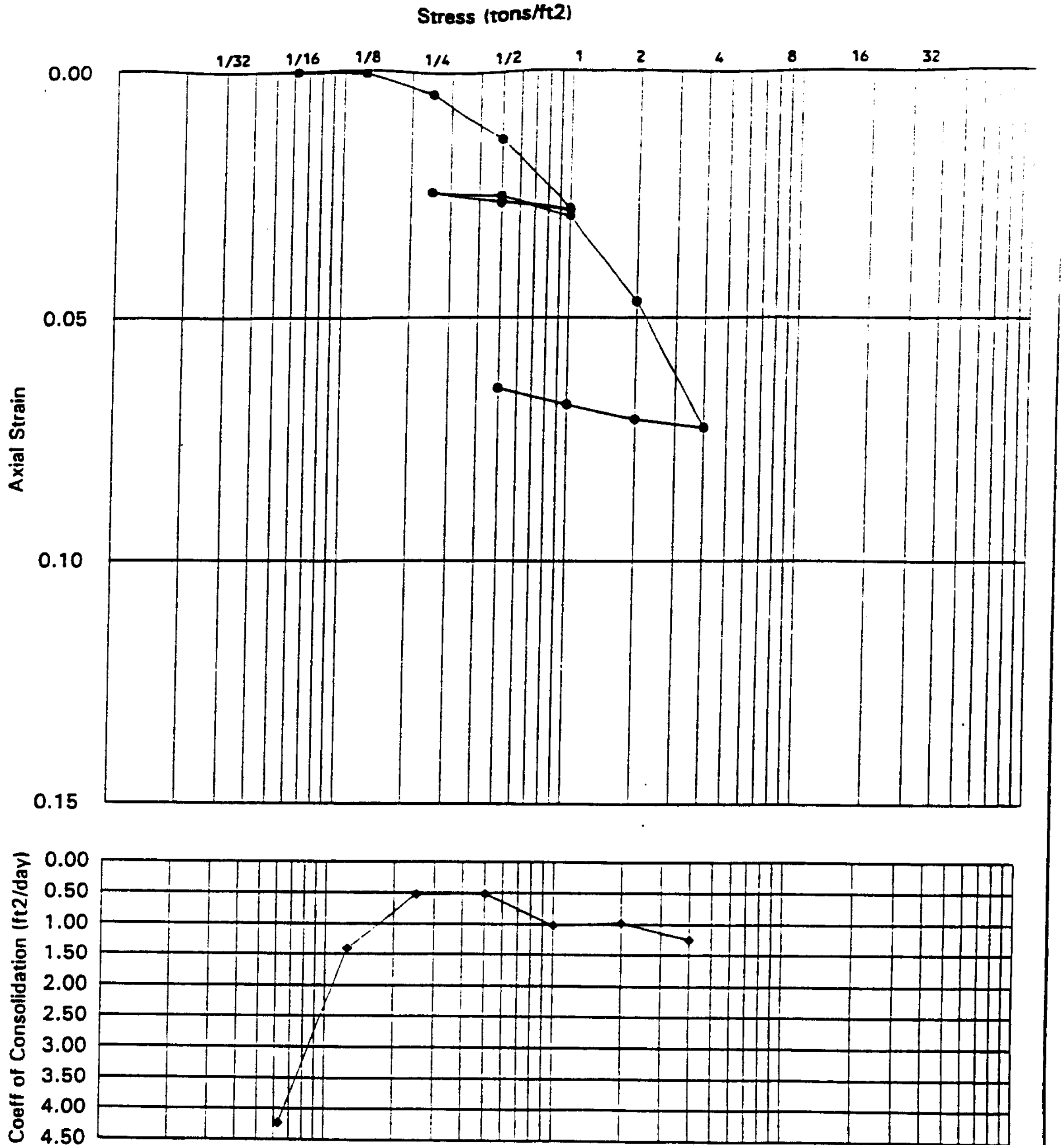
Figure B-18

CONSOLIDATION TEST RESULTS



Expl. No.	Sample No.	Depth (ft)	W.C. % Before	W.C. % After	Atterberg Limit LL	Atterberg Limit PL	Atterberg Limit PI	Wet Wt (pcf)	USC	Description
	S-1	14.3	31%	28%	30	20	10	119 pcf	CL	Clayey SAND

Remarks:

Location: HC99-B47A

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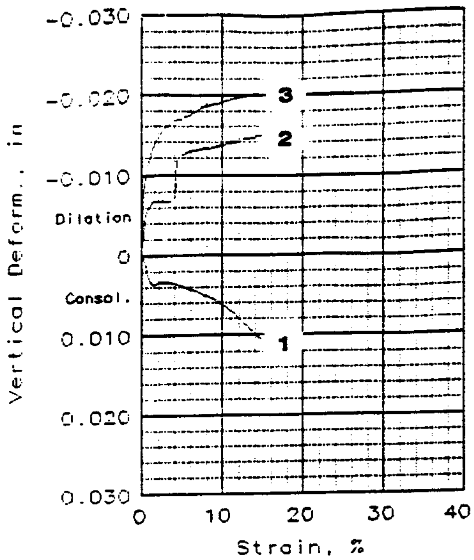
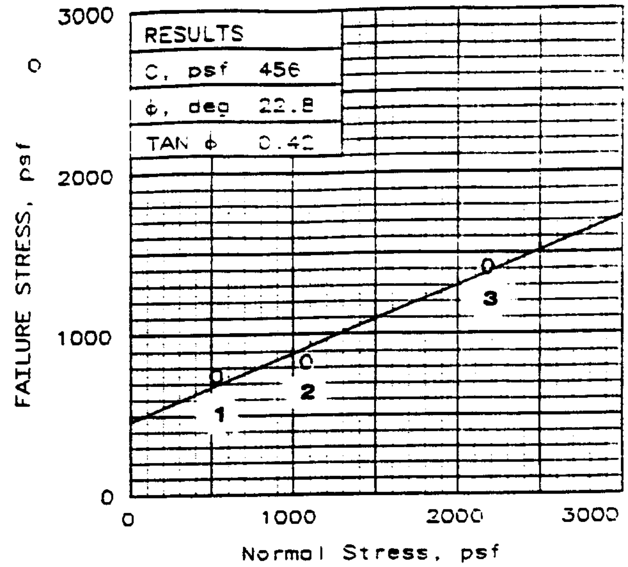
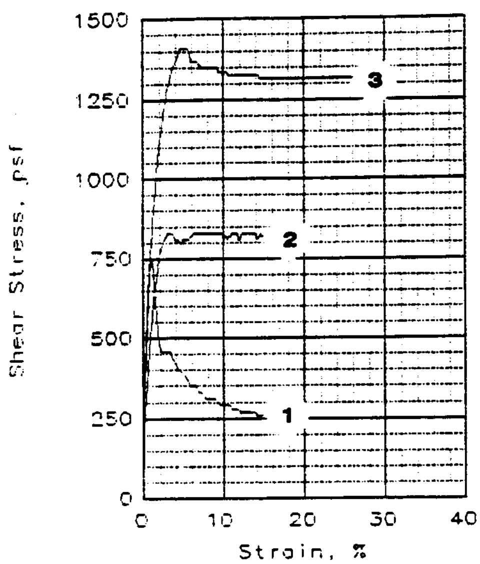
J-4978-06 4/30/99

Figure B-19







SAMPLE NO.:		1	2	3
INITIAL	WATER CONTENT, %	44.1	27.8	12.7
	DRY DENSITY, pcf	87.8	99.0	103.6
	SATURATION, %	132.1	109.7	56.4
	VOID RATIO	0.885	0.672	0.598
	DIAMETER, in	2.42	2.42	2.42
	HEIGHT, in	1.00	1.00	1.00
AT TEST	WATER CONTENT, %	51.0	31.7	27.6
	DRY DENSITY, pcf	87.8	99.0	103.6
	SATURATION, %	152.7	125.0	122.2
	VOID RATIO	0.885	0.672	0.598
	DIAMETER, in	2.42	2.42	2.42
	HEIGHT, in	1.00	1.00	1.00
NORMAL STRESS, psf		550	1100	2200
FAILURE STRESS, psf		746	829	1410
STRAIN, %		1.2	3.0	4.7
ULTIMATE STRESS, psf				
STRAIN, %				
Strain rate, in/min		0.0833	0.0833	0.0833

SAMPLE TYPE: SHELBY TUBE
DESCRIPTION: Sandy CLAY

SPECIFIC GRAVITY= 2.65
REMARKS: UNCONSOLIDATED, SATURATED.

J-4978-06
Figure B-20

CLIENT: HART CROWSER

PROJECT: DIRECT SHEAR TESTING

SAMPLE LOCATION: HC99-B47, S-4

PROJ. NO.: 745-95027 DATE: 5/03/99

DIRECT SHEAR TEST REPORT

PROFESSIONAL SERVICE INDUSTRIES